DRAFT

ENVIRONMENTAL STATEMENT

PROPOSED FOOTHILLS PROJECT

U. S. Department of the Interior

Bureau of Land Management

PREPARED BY

BUREAU OF LAND MANAGEMENT

DEPARTMENT OF THE INTERIOR

STATE DIRECTOR, COLORADO

SUMMARY

(X) Draft ( ) Final Environmental Statement

Department of the Interior, Bureau of Land Management

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Action: The Board of Water Commissioners for the City and County of Denver propose to construct, operate, and maintain waterdiversion facilities on federally managed lands on the South Platte River 25 miles southwest of Denver, Colorado as a part of the proposed Foothills Project. The project would also include a water treatment plant with an ultimate capacity of 500 million gallons per day and a conduit distribution system extending into the Denver metropolitan area. Sources of water would include both the South Platte River and the Blue River via Dillon Reservoir and the Harold D. Roberts Tunnel.

3. Summary of Environmental Impacts:

   Results of the proposed action would include the loss of 1.7 miles of free-flowing river, 1,753 additional tons of sediments, 35 Bighorn sheep, most of the historical narrow gage railbed features, and about 18,000 recreation visits to the South Platte Canyon. The proposed action would also provide for adequate municipal and industrial water in the Denver Metro Area until sometime after 2001, positively impacting that area by maintaining existing life styles until that time.

4. Alternatives Considered:

   A. No Action. (Rejection of the Application)
   B. Major Alternatives
      1. Chatfield Alternative
      2. Upstream Dam
   C. Minor Alternatives
      1. Lower Dam
      2. Elevator Access to the Dam Crest
      3. 14 foot Roadway with Turn-Outs
      4. Buried Power and Telephone Lines
   D. Raw Water Sources Concepts
      1. Concept A
      2. Concept B
      3. Concept C

5. Comments Will Be Requested from the Following:

   See attached list

6. Date Statement Made Available to CEQ and the Public:

   Draft Statement:
   Final Statement:

National Advisory Council on Historic Preservation
Department of Agriculture
- Forest Service
- Soil Conservation Service

Department of Commerce
Department of Defense
- Corps of Engineers

Environmental Protection Agency
Federal Power Commission
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Bureau of Mines
- National Park Service
- Bureau of Reclamation
- Bureau of Outdoor Recreation

Department of Transportation
Water Resources Council
River Basin Commission
- Arkansas River
- Upper Colorado River
- Missouri River

State Historical Society of Colorado
Colorado Division of Wildlife
Colorado Department of Health
- Division of Water Quality
- Division of Air Pollution Control

Colorado Division of Water Resources
Colorado Division of Parks and Outdoor Recreation
Colorado Land Use Commission
Colorado Department of Natural Resources
Colorado State Planning Division
State Clearinghouses
- State of Arizona
- State of California
- State of Colorado
- State of Utah

Colorado Open Space Council
Institute of Ecology
League of Women Voters
National Resources Defense Council
Trout Unlimited
Sierra Club
Rocky Mountain Bighorn Sheep Society
Northern Colorado Educational Board of Cooperative Services
Denver Regional Council of Governments
City of Aurora
- Department of Planning and Community Development

City of Broomfield
    Broomfield Planning Staff
Citizens for Sensible Water
City of Denver
    Department of Planning
Environmental Defense Fund
City of Longmont
    Planning Department
Pikes Peak Council of Governments
Adams County Commissioners
City of Thornton
City of Wheatridge
Boulder County Planning Department
City of Lakewood
South Platte Canyon Preservation Council
Jefferson County Historical Society
Douglas County Historical Society
Park County Historical Society

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CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

INTRODUCTION

Summary

The Board of Water Commissioners for the City and County of Denver (also known as Denver Water Department and hereinafter referred to as the Denver Water Board (DWB)) has applied to the Bureau of Land Management (BLM) for the right to construct, operate, and maintain water-diversion facilities on federally managed lands along the South Platte River approximately 25 miles southwest from downtown Denver, Colorado (Map 1-1). These facilities are a part of a larger DWB proposal known as the Foothills Project. The project would increase the DWB nominal treatment capacity by 125 million gallons per day (mgd), with the capability of expansion to 500 mgd. All components of the proposed Foothills Project are designed to accommodate expansion to a capacity of 500 mgd in the event that population in the DWB treated water service area grows as projected and future additional raw water supplies are developed to satisfy the water needs of the growing population.

The Foothills Project would use water stored during peak spring runoff in the existing Antero, Eleven Mile Canyon, and Cheesman Reservoirs as well as direct flows from the rivers. As needed, west slope water from Dillon Reservoir would be released through the existing Roberts Tunnel and down the North Fork of the South Platte River to supplement direct South Platte reservoir releases. The water would be diverted from the South Platte River by the proposed Strontia Springs Dam and Reservoir into a tunnel (Foothills Tunnel) and conduit (No. 26) system to the proposed treatment plant, about three miles northeast (Map 1-2).

Approximately 11 million kilowatt hours of hydroelectric power would be generated annually at 125 mgd and 78 million kilowatt hours generated annually at 500 mgd by the water near the terminal point of Conduit No. 26. Of this power, 8 million kilowatt hours would be utilized at 125 mgd and 13 million at 500 mgd, to operate the plant. "Raw" water would be treated and passed into another conduit (No. 27) for delivery to the Denver metropolitan area 16 miles northeast (Maps 1-2, 1-3, 1-4). A second identical conduit will be built parallel to Conduit No. 27 when the treatment plant is expanded to 500 mgd. The proposal also includes an intertie conduit with the City of Aurora's raw water system.

CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

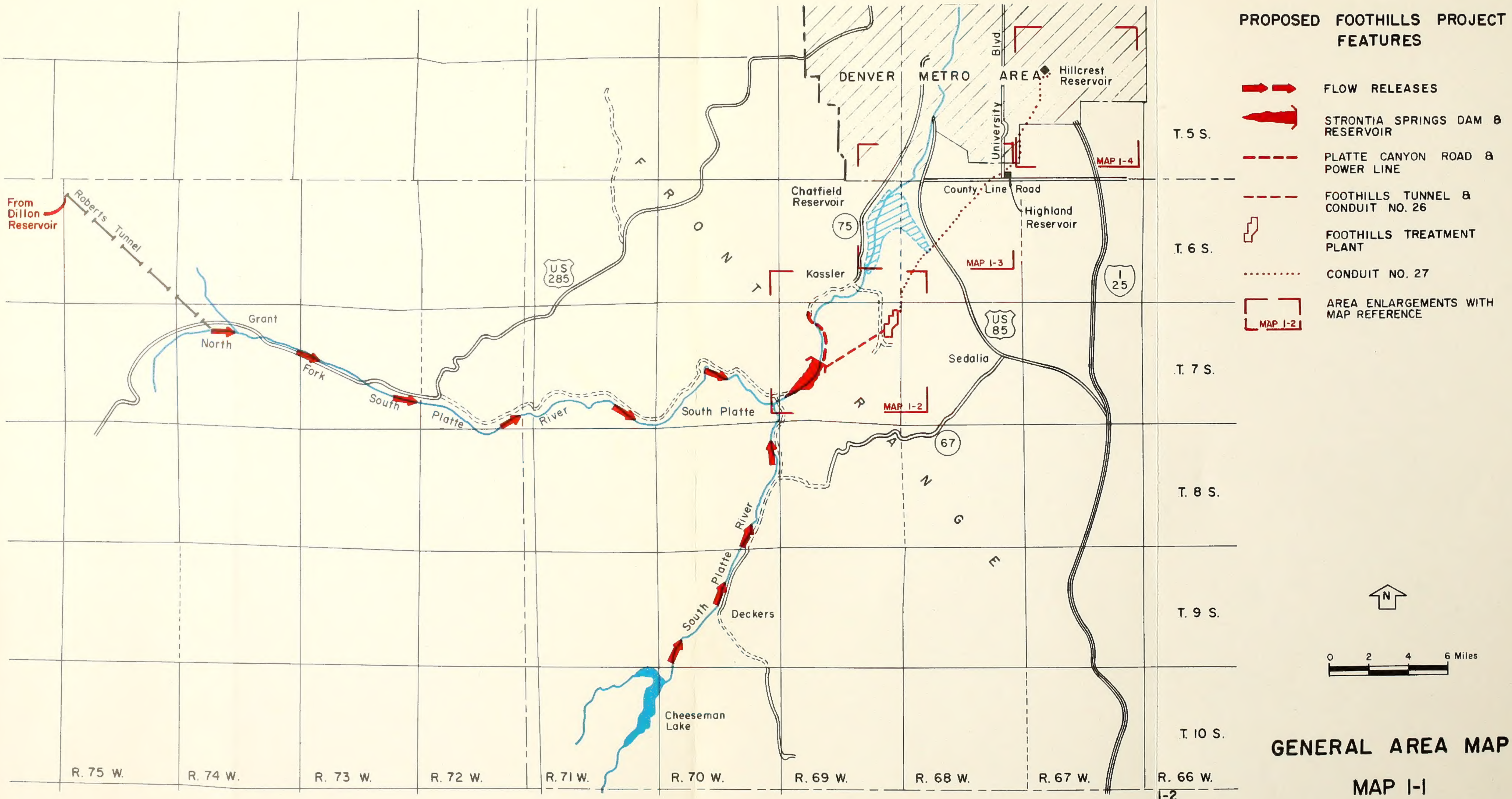
INTRODUCTION

General

The Board of Water Commissioners for the City and County of Denver (also known as Denver Water Department and hereinafter referred to as the Denver Water Board (DWB)) has applied to the Bureau of Land Management (BLM) for the right to construct, operate, and maintain water diversion facilities on federally managed lands along the South Platte River approximately 25 miles southwest from downtown Denver, Colorado (Map 1-1). These facilities are a part of a larger DWB proposal known as the Foothills Project. The project would increase the DWB potable treatment capacity by 125 million gallons per day (mgd), with the capability of expansion to 500 mgd. All components of the proposed Foothills Project are designed to accommodate expansion to a capacity of 500 mgd in the event that population in the DWB treated water service area grows as projected and future additional raw water supplies are developed to satisfy the water needs of the growing population.

The Foothills Project would use water stored during peak spring runoff in the existing Antero, Eleven Mile Canyon, and Cheesman Reservoirs as well as direct flows from the rivers. As needed, west slope water from Dillon Reservoir would be released through the existing Roberts Tunnel and down the North Fork of the South Platte River to supplement direct South Platte reservoir releases. The water would be diverted from the South Platte River by the proposed Strontia Springs Dam and Reservoir into a tunnel (Foothills tunnel) and conduits (No. 26) system to the proposed treatment plant, about three miles northeast (Map 1-2).

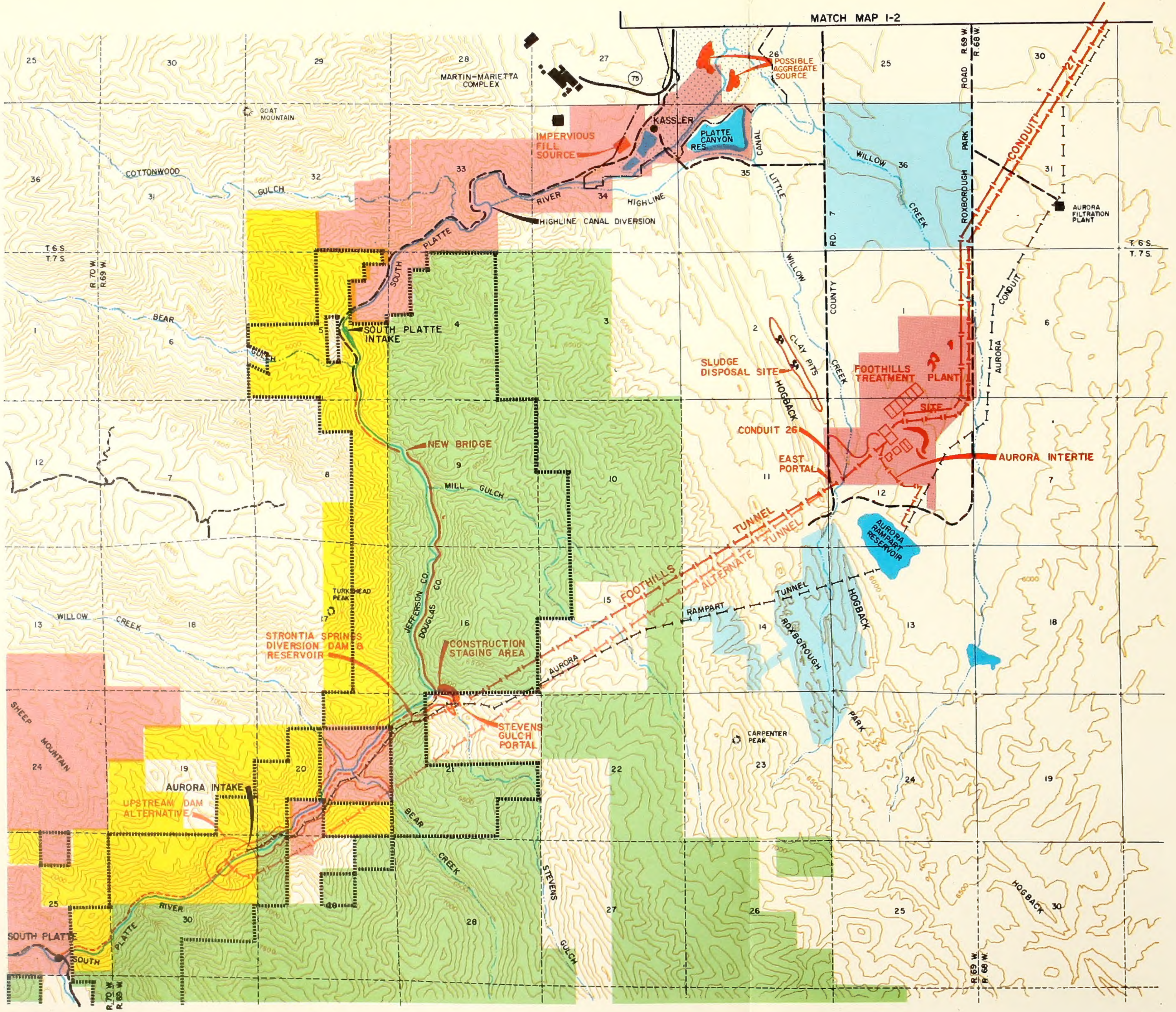
Approximately 17 million kilowatt hours of hydroelectric power would be generated annually at 125 mgd and 78 million kilowatt hours generated annually at 500 mgd by the water near the terminal point of Conduit No. 26. Of this power, 8 million kilowatt hours would be utilized at 125 mgd and 13 million at 500 mgd, to operate the plant. "Raw" water would be treated and passed into another conduit (No. 27) for delivery to the Denver metropolitan area 15 miles northeast (Maps 1-4, 1-5, 1-6). A second identical conduit will be built parallel to Conduit No. 27 when the treatment plant is expanded to 500 mgd. The proposal also includes an interim conduit with the City of Aurora's raw water system.



GENERAL AREA MAP

MAP I-1

PROPOSED FOOTHILLS PROJECT



EXISTING FEATURES: (IN BLACK OR BLUE)

- DIRT ROAD
- GRAVEL ROAD
- PAVED ROAD

PROPOSED PROJECT FEATURES: (IN RED)

- IMPROVEMENT TO 12-FOOT ROAD WITH TURNOUTS
- IMPROVEMENT TO 14-FOOT ROAD WITH TURNOUTS INCLUDING POWER & TELEPHONE LINES
- IMPROVEMENT TO 22-FOOT GRAVEL ROAD INCLUDING POWER & TELEPHONE LINES

MAJOR ALTERNATIVE: UPSTREAM DAM

FUTURE PIPELINE IN DWB R/W FOR CONDUIT NO. 27

LAND OWNERSHIP:

- COLORADO STATE
- BUREAU OF LAND MANAGEMENT
- NATIONAL FOREST
- NATIONAL RESOURCE LANDS (BLM) AND NATIONAL FOREST LANDS SET ASIDE FOR POWER SITE PURPOSES, POWER PROJECTS OR RECLAMATION PROJECTS
- DENVER WATER BOARD
- CORPS OF ENGINEERS
- OTHER NONFEDERAL

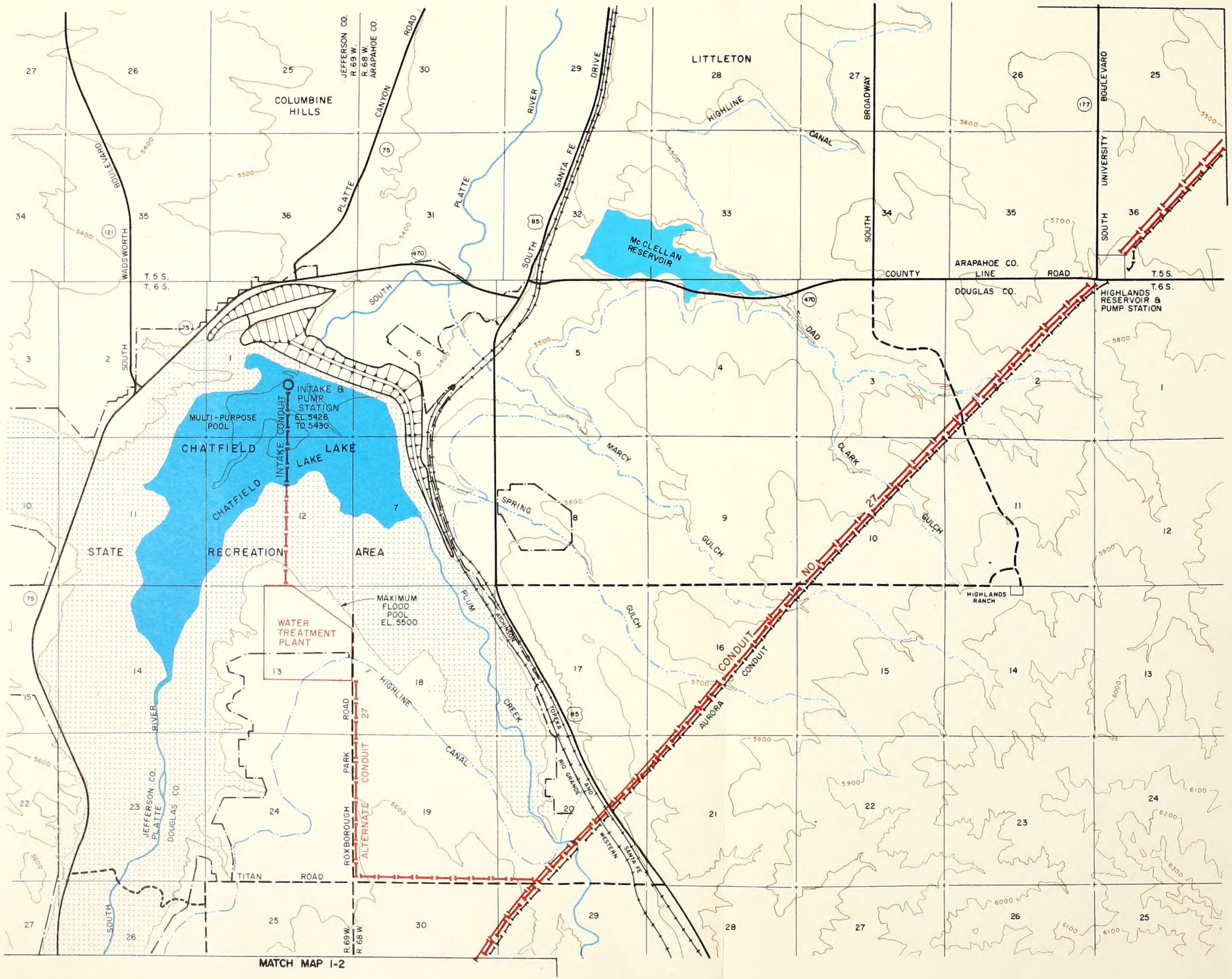
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP - FOOTHILLS

MAP I-2



PROPOSED FOOTHILLS PROJECT

EXISTING FEATURES : (IN BLACK OR BLUE)

- DIRT ROAD
- GRAVEL ROAD
- PAVED ROAD

PROPOSED PROJECT FEATURES : (IN RED)

MAJOR ALTERNATIVE :

CHATFIELD

LAND OWNERSHIP :

CORPS OF ENGINEERS

NONFEDERAL

FUTURE PIPELINE IN DWB R/W FOR CONDUIT NO. 27

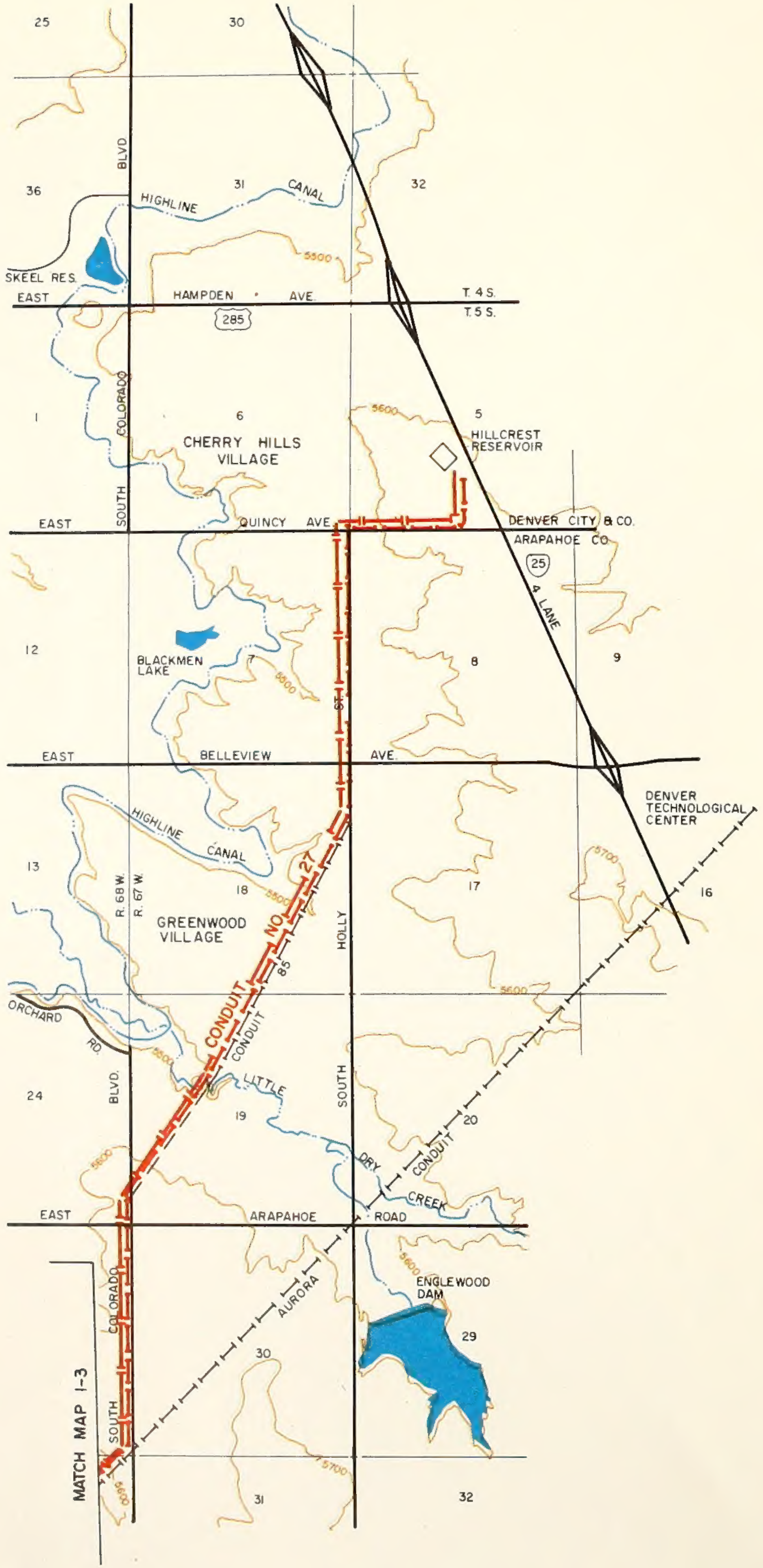
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

MAP I-3



PROPOSED FOOTHILLS PROJECT

EXISTING FEATURES: (IN BLACK OR BLUE)

- - - - - - DIRT ROAD

— — — GRAVEL ROAD

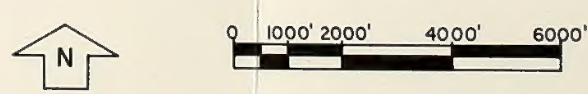
———— PAVED ROAD

PROPOSED PROJECT FEATURES: (IN RED)

LAND OWNERSHIP:

NONFEDERAL

FUTURE PIPELINE IN DWB R/W FOR CONDUIT NO. 27



DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP—HILLCREST RESERVOIR

MAP I-4

Background and History

In the early 1900s, plans were devised to divert and use water from the Upper South Platte and Blue Rivers to serve customers in the Denver area. Use of these waters began with the construction of Cheesman Dam in 1905 and was expanded in the 1930s with the purchase of Antero Reservoir and the construction of Eleven Mile Reservoir on the South Platte system. In 1963, Roberts Tunnel and Dillon Reservoir were completed by the DWB for diversion of west slope water from the Blue River system to the east slope.

Serious plans for the proposed Foothills Project were initiated by the DWB during 1952-1955 with a preliminary survey of the Foothills Tunnel and the treatment plant site. In 1956, the DWB prepared the first plans for Strontia Springs Diversion Dam and purchased 200 acres for a treatment plant. In 1957, the route of proposed Conduit No. 27 to Denver was surveyed. In 1962, the DWB filed its original application for those parts of Strontia Springs Diversion Dam and Reservoir, Conduit No. 26 and the Foothills Tunnel on federally managed lands as a part of the proposed Foothills Project. A report to the DWB (Black and Veatch 1963) recommended completion of the first treatment plant unit in 1977.

In 1967, BLM issued a right-of-way permit (C-099597), which allowed the DWB five years to construct the Strontia Springs Diversion Dam and Reservoir, conduits, and tunnel. In 1973, the DWB requested and was granted an extension of time, to submit an amended application based on changes in the original design and to complete construction. The letter from BLM granting the extension indicated the need for analysis of the action in compliance with Public Law (PL) 91-190, the National Environmental Policy Act of 1969 (NEPA). DWB studies culminated in the Foothills Predesign Report in November 1973 and the Foothills Project, Environmental Impact Assessment in April 1974. In January 1974 the DWB filed another request for a one-year extension of time to prepare and submit an amended filing and for three years to construct. After receiving these amended filings, BLM decided to comply with NEPA prior to acting on DWB's request.

An amendment to the original right-of-way permit was received from the DWB in November 1974. A new application for road access to the proposed damsite across federally managed land was filed in October 1974. From these applications the Department of the Interior determined that the action as proposed could significantly affect the quality of the human environment and began preparation of this environmental impact statement, as required by Section 102(2)(C) of NEPA. In February 1975, the Department determined that this environmental impact statement

should be project-specific in scope and consider the effects of construction and operation of the dam, reservoir, ancillary facilities in the canyon of the South Platte River, the treatment plant, and the water supply, along with delivery tunnels and conduits.

This original draft environmental statement was filed with the Council on Environmental Quality (CEQ) December 1975 and issued in January 1976. Public hearings were conducted February 19, 1976. July 8, 1976, the Regional Solicitor ruled that the scope of this draft environmental statement was insufficient as a matter of law, and recommended that the Secretary of the Interior postpone his decision on the Foothills proposal pending comprehensive analysis.

On November 1, 1976, the Under-Secretary of the Department of the Interior for Land and Water Resources sent a memorandum to the Colorado State Director of the BLM outlining the requirement for a new draft environmental statement covering the proposed Foothills Project. A supplementary memorandum from Mr. Horton on December 27, 1976, further elucidated the requirement for an expansion of the existing draft statement, for the express purpose of providing a sound basis for decision-making between the Department of the Interior, the State of Colorado, and the DWB. The scope of the potential impacts studied was enlarged to include the effects of the treatment plant being implemented at the 500 mgd level and a discussion of new sources of raw water needed to meet the 500 mgd capacity of the Foothills Treatment Plant.

GOVERNMENTAL ACTIONS

This section includes a description of actions required to approve or disapprove all or any part of the proposed action by issuing or not issuing a permit, grant, right-of-way, or license. Agencies discussed are the Bureau of Land Management, the United States Forest Service, the Federal Power Commission, Corps of Engineers, the Advisory Council on Historic Preservation and the Colorado Department of Health, each of which would issue necessary grants or permits under their respective authorities.

Bureau of Land Management

The DWB has filed two right-of-way applications with BLM. The first application, dated October 4, 1974, and identified by serial number C-22081, is for the Platte Canyon Road. The second application, dated November 4, 1974, is an amendment of right-of-way C-099597 for the Strontia Springs Diversion Dam, Reservoir, and Foothills tunnel.

The amendment would affect a right-of-way originally granted April 20, 1967, using as authority the Act of February 15, 1901 (31 Stat. 790; 43 U.S.C. 959) as to public lands, and Section 1 of the Act of February 1, 1905 (33 Stat. 628; 16 U.S.C. 524) as to national forest lands.

Both of these Acts were repealed by Section 706 of the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2793). Section 501 of the Act authorizes the Secretary of the Interior to grant rights-of-way over, upon, under, and through the public lands for the various purposes that would satisfy the DWB municipal water development plans described in their pending applications. While regulations have not been issued to implement Sections 501 through 511 of the Act with respect to rights-of-way, this is the authority under which DWB would be permitted to use public land for the Foothills Project.

The applications filed include the following features, outlined in Table 1-1. The rights-of-way limits shown are preliminary estimates of the widths that would be permitted under Section 504(a)(1) through (4) of the Act.

TABLE 1-1

SUMMARY OF RIGHT-OF-WAY APPLICATIONS
ON BUREAU OF LAND MANAGEMENT LAND

Feature	Right-of-Way Limits	Area or Distance BLM Lands
Strontia Springs Dam, Reservoir	50 feet from marginal limits of maximum pool level	22 acres
Platte Canyon access road, including 1,696 feet on BLM land which would be inundated by the proposed reservoir	50 feet each side of center line	29 acres (12,629 feet)
Total		51 acres

If approved, the right-of-way grants would allow the DWB a reasonable but as yet undetermined time within which to construct the facilities described and give the DWB the right to operate and maintain those facilities for the duration of beneficial use. The grants would not give the DWB any estate of any kind in fee in the lands involved. The interest granted would not allow the removal of any material except that necessary for the construction of the project.

If rights-of-way are granted, two other permits would be necessary. The Public Service Company of Colorado would file for an extension of a 13.2-kilovolt overhead power line of about 2.8 miles from the South Platte Intake to the dam site of which 1.4 miles would be on BLM land. Mountain Bell would file for extension of a telephone line over the same distance, attached to the same poles.

The final decision regarding such land use authorizations would consider environmental factors, land use criteria, and economic considerations. The final environmental impact statement including the actions applied for must be filed with the Council on Environmental Quality for at least 30 days before a final decision can be rendered.

The decisions for the two rights or way (dam and road) lie with the Director of the Colorado State Office, BLM, with prior review and concurrence by the Director, BLM.

United States Forest Service

The DWB application to amend the right-of-way C-099597, for the Strontia Springs Dam, Reservoir and the Foothills Tunnel, which this environmental statement addresses, involves a right-of-way originally granted April 20, 1967 by the BLM, under authority of Section 4 of the Act of February 1, 1905 (33 Stat. 628; 16 U.S.C. 524) as to national forest lands involved. This act was repealed by Section 706 of the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2793). Section 501 of the Act authorizes the Secretary of Agriculture to grant rights-of-way over, upon, under, and through national forest lands for the various purposes that would satisfy the DWB municipal water development plans described in the application to amend C-099597. The U.S. Forest Service will grant one permit for five rights-of-way to DWB. These separate rights-of-way are described in Table 1-2.

Federal Power Commission

Pursuant to Part I of the Federal Power Act of June 10, 1920 (41 Stat. 1075) as amended, the Federal Power Commission (FPC) is responsible for licensing non-Federal hydroelectric projects located on streams over which Congress has jurisdiction, or projects which affect

TABLE 1-2

SUMMARY OF RIGHT-OF-WAY APPLICATIONS
ON NATIONAL FOREST LANDS

Feature	Right-of-Way Limits	Area or Distance (U.S. Forest Service Lands)
Strontia Springs Dam, Reservoir	50 feet from marginal limits of maximum pool level	16 acres
Foothills Tunnel	50 feet each side of center line	10 acres (4,457.86 feet)
Dam abutment road	50 feet each side of center line	2 acres (848.83 feet)
Dam outlet works road	50 feet each side of center line	2 acres (885.78 feet)
Platte Canyon access road (including 1,802 feet which would be inundated by the proposed reservoir)	50 feet each side of center line	30 acres (12,870.45 feet)
Total		60 acres

public lands and reservations of the United States. The DWB proposes to install hydro-generators near the terminal point of Conduit No. 26 which would produce 1,050 to 1,600 kilowatts of electrical energy per hour (1,400 to 2,150 horsepower). The generators would also serve to dissipate the water force near the end of that conduit. Indications are that the generators would not be an essential element of the project because other mechanisms could be used for the same energy dissipation purpose without any change in the overall project design.

At present, the DWB has not applied to the FPC for a license to construct and operate the proposed Foothills hydroelectric plant. The DWB has indicated that, since this part of its proposed project is not dependent on other project components, it would not file the necessary application until a decision is reached by the BLM and the U.S. Forest Services (USFS) concerning rights-of-way. This plan would allow the FPC about three years to act on the application for the license. The FPC would reach a final decision based on the need for power production as well as environmental and economic factors.

Corps of Engineers

The Corps of Engineers is charged with administration of Section 404 of the Federal Water Pollution Control Act (PL 92-500). Section 404 of that Act (33 USC 1344) requires a permit be obtained from the Corps prior to the discharge of any fill material into a navigable stream. Under present definitions a dam is considered fill material and the South Platte River is a navigable stream. In addition the access road work along the South Platte River below the dam will cause other fill material to be deposited in that stream. Therefore, the DWB must obtain a permit before it can begin these construction activities in the South Platte River.

Other construction activities deemed necessary by BLM's mitigating measures as presented in Chapter 4 of this document will require separate 404 permit applications by the DWB.

Colorado Department of Health

During construction of the proposed Foothills Tunnel and Strontia Springs Dam in the South Platte Canyon, the DWB expects a certain amount of water pollutants to be generated. This amount could possibly exceed State and Federal stream standards established as a result of the Federal Water Pollution Act of 1972 (PL 92-500) and amendments. In order to comply with this Act and Colorado Department of Health regulations, the DWB or its contractor(s) must apply for a stream discharge permit at least 180 days prior to the expected discharge. The application must include a map or other means of identifying the possible points of

discharge, expected pollutants, and proposed treatment. The Colorado Department of Health, Water Quality Control Division, will evaluate the proposed treatment in relation to the type of pollutants expected and determine whether the treated water would meet standards established by the State in cooperation with the EPA through the National Pollutants Discharge Elimination System. The permit, if issued, would establish limitations of pollutants expected.

Enforcement of the permit by the State would involve periodic water testing at the identified discharge points on the South Platte River. If the limitations imposed on the expected pollutants were exceeded, the State would seek to have the situation corrected immediately. If no corrective measures were taken voluntarily, legal action could be taken to stop construction until better treatment was provided.

The Environmental Protection Agency also has enforcement authority similar to that of the Colorado Department of Health and could seek corrective measures in a similar manner.

Local Governmental Agencies

Prior to construction of principal project features, DWB would have to obtain special land use permits from four counties and from one incorporated city.

A summary of authorizing actions follows, in Table 1-3.

PROPOSED ACTION

Purpose and Need

The proposed Strontia Springs Diversion Dam and Reservoir and Foothills Water Treatment Plant would be a part of the DWB South Platte River water supply system. Construction of the facilities would enable the DWB to provide treated water to the increasing population within the DWB treated-water service area and to other users at levels in keeping with current trends of consumption. Map 1-5 shows the DWB's present service area. Map 1-6 shows its projected future service area.

Table 1-4 presents projected estimates of future population within the DWB treated water service area, given by the Denver Regional Council of Governments (DRCOG). The DRCOG figures are the basis for DWB's planned water system development. The socio-economic subgroup of the Foothills Environmental Team concurred in these figures. This group

TABLE 1-3

SUMMARY OF AUTHORIZING ACTIONS

Project Component	Required Authorization	Responsible Federal, State, or Local Agency
Dam, Reservoir, and Tunnel	Right-of-way permit	Bureau of Land Management
Dam, Reservoir, and Tunnel	Right-of-way permit	U.S. Forest Service
Dam, Reservoir, and Tunnel	Hydropower generation license	Federal Power Commission
Dam, Reservoir, and Tunnel	Section 404 permit	Corps of Engineers
Dam, Reservoir, and Tunnel	Sec. 106 Determination	Advisory Council on Historic Preservation
Dam, Reservoir, and Tunnel	Stream discharge permit	Colorado Department of Health
Access Roads	Right-of-way permit	Bureau of Land Management
Access Roads	Right-of-way permit	U.S. Forest Service
Access Roads	Section 404 permit	Corps of Engineers
Access Roads	Sec. 106 Determination	Advisory Council on Historic Preservation
Access Roads	Stream discharge permit	Colorado Department of Health
Power and Telephone Lines	Right-of-way permit	Bureau of Land Management
Power and Telephone Lines	Right-of-way permit	U.S. Forest Service
All Project Components	Special land use permits	Various units of local government

included the Colorado Division of Planning, the Department of Housing and Urban Development, the Environmental Protection Agency, the Bureau of Reclamation, and the Bureau of Land Management.

In addition to providing treated water to the metropolitan area, the DWB provides raw water to various users. These include the City of Arvada, the North Table Mountain Water and Sanitation District, and various industries such as Public Service Company of Colorado and Rockwell International Corporation.

As shown in Table 1-4, raw water supplied to these users constitutes less than ten percent of the demand for treated water that is met annually. In addition, projections indicate that this percentage will decrease.

Treated water, then, is the principal component of demand in the DWB water supply system. Following is a somewhat simplified schematic of how the DWB treated-water supply system operates. Delivery of treated water to its customers involves two factors, (1) the collection and storage of raw water in sufficient amounts to meet long-term demand and (2) treatment of that raw water at a fast enough rate to meet short-term demand, as it occurs.

The basis for long-term planning in the collection and storage of raw water is annual demand - the total volume (measured in acre-feet) of raw and treated water consumed in a given year in the DWB service area. Planning involves balancing the needs of customers as reflected by annual demand against capacities for collection and storage. In wet years, a surplus of water is stored to help compensate for the lack of water available for collection in dry years. Using data on water collection extending over a period of years, it is possible to calculate the amount of water that is "reliably" available in any given year to meet annual demand in the service area. "Reliable" supply tends to be a conservative estimate of the amount of water that can be used year to year without too much risk of a gradual and ultimate depletion of the resource.

The other aspect of water supply is treatment capacity - the rate at which raw water can be treated and delivered to customers. After raw water is stored, it is selectively released into a network of man-made (e.g., conduits and tunnels) and natural (e.g., stream and rivers) conveyances to treatment plants. In the DWB system, three treatment plants act in coordination to supply the Denver service area with treated water. The combined capacities of these plants must be sufficient to meet the peak daily (max-day) and hourly (max-hour) demands. When their capacity is not sufficient, a temporary shortage occurs. This shortage, if caused solely by inadequate treatment capacity, is only an apparent one. There may be plenty of water in storage, but it cannot be treated fast enough to meet these demands. Such a situation is discussed and illustrated later, in Chapter 8 (Figure 8-1) in the Socio-Economic Implications section under the No Action alternative.

including the Colorado Division of Planning, the Department of Housing and Urban Development, the Environmental Protection Agency, the Bureau of Reclamation, and the Bureau of Land Management.

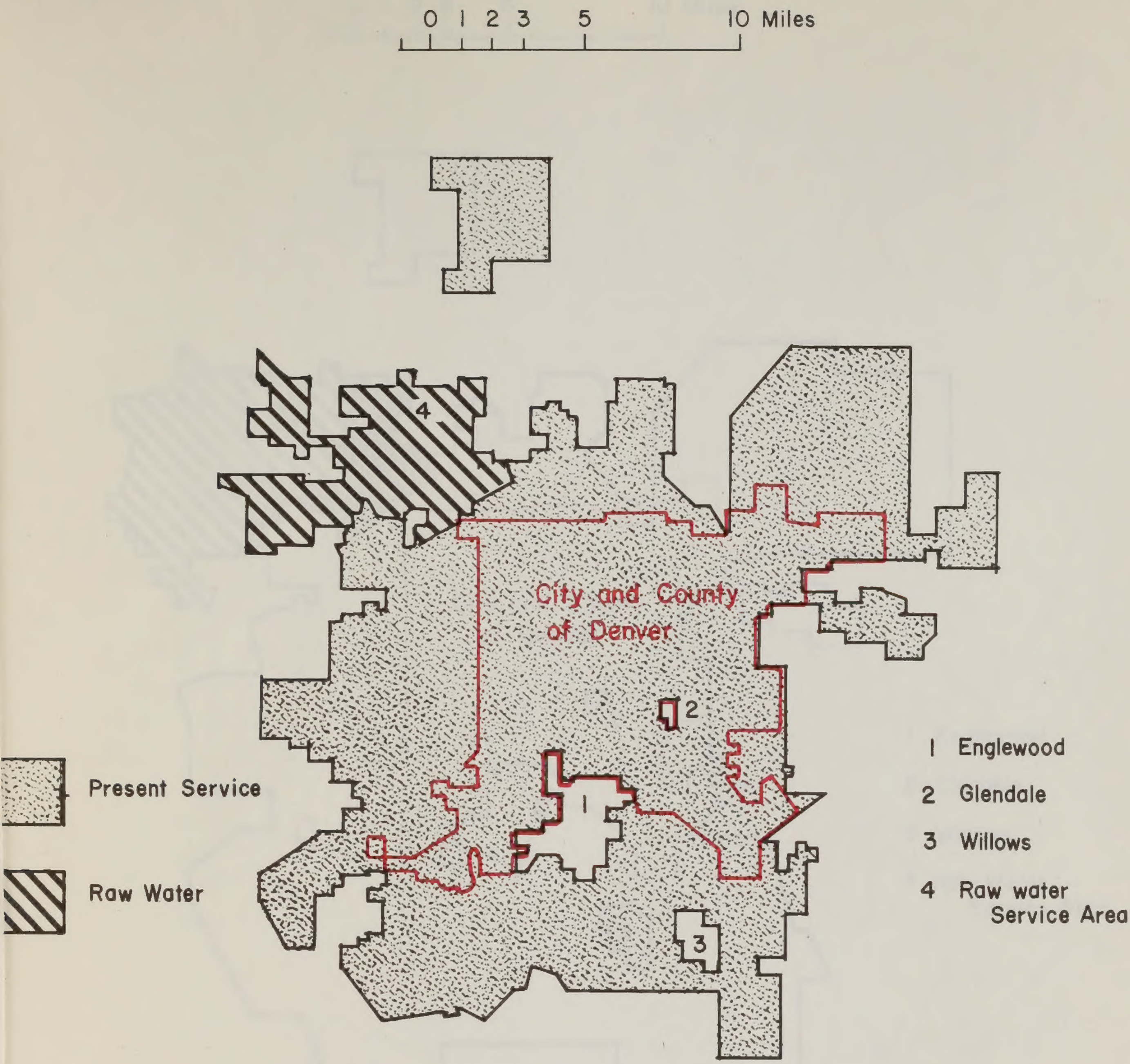
In addition to supplying treated water in the metropolitan area, the DWD provides raw water to various users. These include the City of Thornton, the North Table Mountain Water and Sanitation District, and various irrigators such as Public Service Company of Colorado and various agricultural organizations.

As shown in Table 2.6, raw water supplied to these users constitutes less than ten percent of the demand for treated water that is met by the DWD. In addition, projections indicate that this percentage will decrease.

Treated water, then, is the principal commodity of concern in the DWD water supply system. Following is a somewhat simplified discussion of the two key elements of water supply system operation. Delivery of treated water to its customers involves two factors: (1) the collection and storage of raw water in sufficient amounts to meet long-term demand and (2) treatment of that raw water at a rate rapid enough to meet short-term demand, as it occurs.

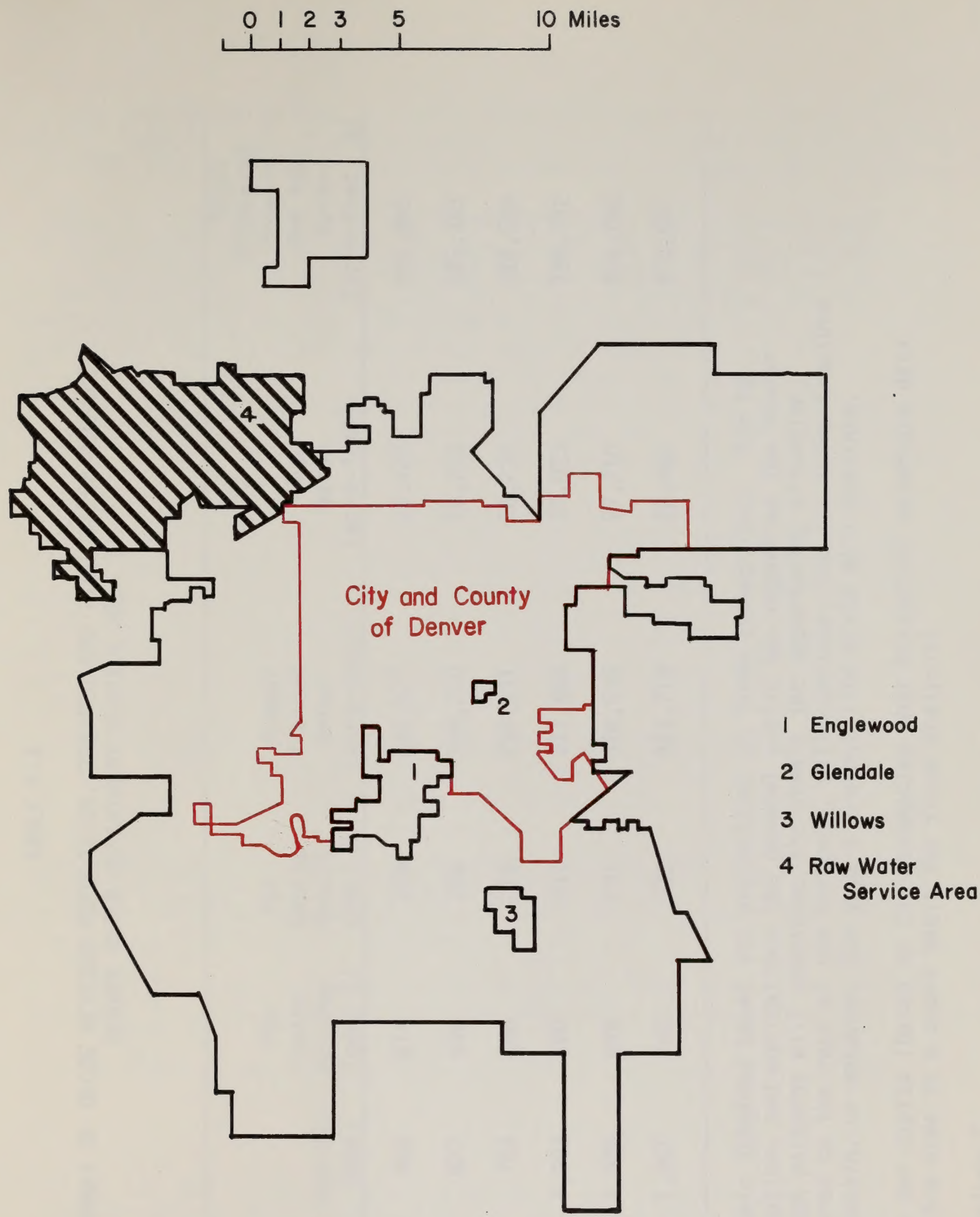
The basis for long-term planning in the collection and storage of raw water is annual demand. The total volume (measured in acre-feet) of raw and treated water consumed in a given year in the DWD service area provides a means of balancing the needs of customers as reflected by annual demand against capabilities for collection and storage. In wet years, a surplus of water is stored to help compensate for the lack of water available for collection in dry years. Using data on water collection extending over a series of years, it is possible to determine the amount of water that is "reliably" available in any given year to meet annual demand in the service area. This "safe annual yield" is thus a conservative estimate of the amount of water that can be used year to year without such risks of drawdown and ultimately depleting the resource.

The other aspect of water supply is treatment capacity -- the rate at which raw water can be treated and delivered to customers. After raw water is stored, it is selectively released into a network of man-made (e.g., tunnels and canals) and natural (e.g., streams and rivers) conveyances to treatment plants. In the DWD system, three treatment plants act in coordination to supply the Denver service area with treated water. The combined capabilities of these plants must be sufficient to meet the peak daily (one-day) and hourly (one-hour) demands. When their capacity is not sufficient, a temporary shortage, or distribution shortage, is caused solely by inadequate treatment capacity. It is only an apparent one. There may be plenty of water in storage, but it cannot be treated fast enough to meet these demands. Such a situation is discussed and illustrated later in this chapter (Figure 2.7) in the Socio-economic Implications section under the No Action alternative.



PRESENT DENVER SERVICE AREA

MAP 1-5



FUTURE DENVER SERVICE AREA
MAP 1-6

TABLE 1-4

SUMMARY OF DRCOG REVISED POPULATION, TREATED AND TOTAL WATER DEMANDS
DENVER WATER DEPARTMENT SERVICE AREA 1/

Year	Population	Max-Day (mgd)	Per Capita Max-Day (gdc) 2/	Per Capita Annual (gdc) 2/	Annual Treated Water (acre-feet)	Raw Water (acre-feet)	Total Delivered Treated And Raw Water (acre-feet) 3/
1980	958,400	589	614	226	242,977	24,922	267,899
1985	1,057,200	672	636	228	269,710	26,243	295,953
1990	1,162,900	763	656	229	298,331	26,238	324,569
2000	1,434,100	1,003	699	231	371,509	27,023	398,532
2001 4/	1,460,100	1,020	699	231	378,530	27,210	405,740
2010	1,693,700	1,257	742	233	441,719	28,962	470,681

1/ The socio-economic subgroup based its projections on three assumptions: due to favorable perceptions and motivations the general public has regarding the Denver area, past growth patterns will continue; the area's job opportunity situation, favorable compared to the rest of the nation's, will continue; and the infrastructure necessary to sustain, or enhance, the area's present life style will continue.

2/ Gallons per day per capita (based on the assumption that historical water-use data in the DWB service area is a sound basis for trend analysis).

3/ Column 6 plus column 7.

4/ 2001 is shown here because this is the year in which the max-day demand reaches 1020 mgd.

The capacity of water treatment plants is expressed in millions of gallons per day (mgd). Table 1-4 presents the projected max-day and per capita max-day demand in the DWB service area through the year 2010.

Present usable DWB treatment plant capacity is 520 mgd. As shown in Table 1-4, the total treatment capacity of 520 mgd is expected to be exceeded by 1980. Implementing the Foothills Treatment Plant at full capacity (500 mgd) would increase the total treatment capacity of the DWB to 1,020 mgd. According to projections in Table 1-4, this treatment capacity will be sufficient to meet max-day demand until the year 2001, when max-day demand will equal the total capacity of the DWB system. Because 2001 is the year the DWB treated water system with the addition of the proposed facilities would be taxed to its limit, that year was selected as the time to measure the project's impacts.

Table 1-5 presents a projection, based on DRCOG population projections, of the number of days when the max-day demand would exceed the existing DWB collective treatment plant capacity of 520 mgd and thereby create apparent, temporary shortages.

TABLE 1-5

PROJECTION OF DAYS WHEN MAX-DAY DEMAND WOULD EXCEED TREATED WATER SUPPLY - DWB SERVICE AREA (AT EXISTING 520 mgd CAPACITY)

Year	Number of Days When Demand Exceeds Treatment Capacity	Probable Max-day Volumes (mgd)
1980	13	589
1985	31	672
1990	40	763
2000	63	1,003
2010	73	1,257

The construction of the Strontia Springs Diversion Dam and Foothills Treatment Plant at 125 mgd would enable the DWB to use greater amounts of raw water presently available from its existing collection-storage-diversion system. With the additional 125 mgd treatment plant capacity, demands associated with the growing population within the treated water service area could be met until around 1983. Increasing plant capacity to 500 mgd would enable the DWB to treat additional raw water, not yet developed, to meet max-day demand until about 2001.

Initially, no additional raw water supplies would have to be developed for the Foothills Project. The existing system can provide an adequate raw water supply for treatment at the existing plants (520 mgd) and the Foothills Treatment Plant at its proposed initial capacity of 125 mgd.

The present reliable annual raw water supply delivered to treatment plant intakes averages 298,000 acre-feet. In addition, 14,300 acre-feet of water is available to the DWB from Bear Creek and South Platte River ditch rights. These rights give the DWB a total average raw water supply of 312,300 acre-feet annually.

Reliable supply is estimated by means of simulated operation of the DWB system using the historical runoff conditions that were experienced during the 1947-1965 period. Collection and storage of runoff in the existing system was considered and the water routed through the system and delivered to the metropolitan area based on a monthly historical pattern.

The operation at capacity of the Foothills Treatment Plant at 125 mgd would create a demand for raw water on the South Platte River at the Strontia Springs Diversion Dam of approximately 195 cubic feet per second (cfs). If the Marston and Kassler Treatment Plant intakes are also diverting water at capacity, there will be demand for a total of 595 cfs of raw water from the South Platte River. Sources from which such demand for raw water would be met are the DWB's existing South Platte and Roberts Tunnel Systems.

The proposed Foothills Project features, with one exception, are designed to accommodate expansion to a capacity of 500 mgd, in the event

that population in the DWB treated water service area grows as projected and future additional raw water supplies must be developed. The exception is distribution Conduit No. 27, which is designed to accommodate only 350 mgd.

Operation of the Foothills Treatment Plant at capacity (500 mgd) would create a demand for 773 cfs of raw water on the South Platte River at the Strontia Springs Diversion Dam. If the Marston and Kassler Treatment Plant intakes are also diverting water at capacity, there will be demand for a total of 1,176 cfs of raw water from the South Platte River (for producing treated water at the rate of 760 mgd). Sources from which this year 2001 demand for raw water would be met are the DWB's existing South Platte and Roberts Tunnel Systems and potential additional sources or combinations of sources discussed in Chapter 8.

The addition of the proposed 125 and 500 mgd Foothills Treatment Plant is anticipated to change the pattern of operation of existing DWB treatment plants. Except during brief periods for maintenance, the Foothills Treatment Plant would operate at or near capacity on a year-around basis, in order to take advantage of its higher elevation (5,860 feet). Figure 1-1 shows the relative elevations of the various DWB storage reservoirs. The higher elevation of Foothills Treatment Plant would reduce the amount of pumping required for distributing treated water throughout the DWB treated-water service area. The Moffat, Marston, and Kassler Treatment Plants would be used primarily to supply the peak demands of the summer and, as necessary, to augment the treated water supply required during other times of the year.

The initial 125 mgd operating capacity would increase the total DWB treatment capacity to 645 mgd. Increasing the Foothills Plant to 500 mgd would provide a total of 1,020 mgd treatment capacity.

Construction of the Foothills project would provide for an electric power savings over the present operational system. This power savings at the 125 mgd development level would be 16 million kilowatt-hours and at the 500 mgd development level would be 47.9 million kilowatt-hours.

Description of the Proposed Foothills Project

General Facilities Description

The description of the proposed facilities which follows is comprised of information obtained from The Foothills Project Environmental Assessment (DWB 1974), The Foothills Project Predesign Report (Board of Water Commissioners 1973), BLM official case files for rights-of-way C099597

(Strontia Springs Dam and Reservior, conduits, and tunnel) and C-22081 (Platte Canyon access road) and additional data supplied by DWB. All details in the description are current as of January 1977. All components described would be needed for implementation at both the 125 and the 500 mgd level.

The proposed construction of the Foothills Project would cost about $234 million (1976). Table 1-6 reflects total resources which would be committed to project construction at 500 mgd, including first 125 mgd increment cost.

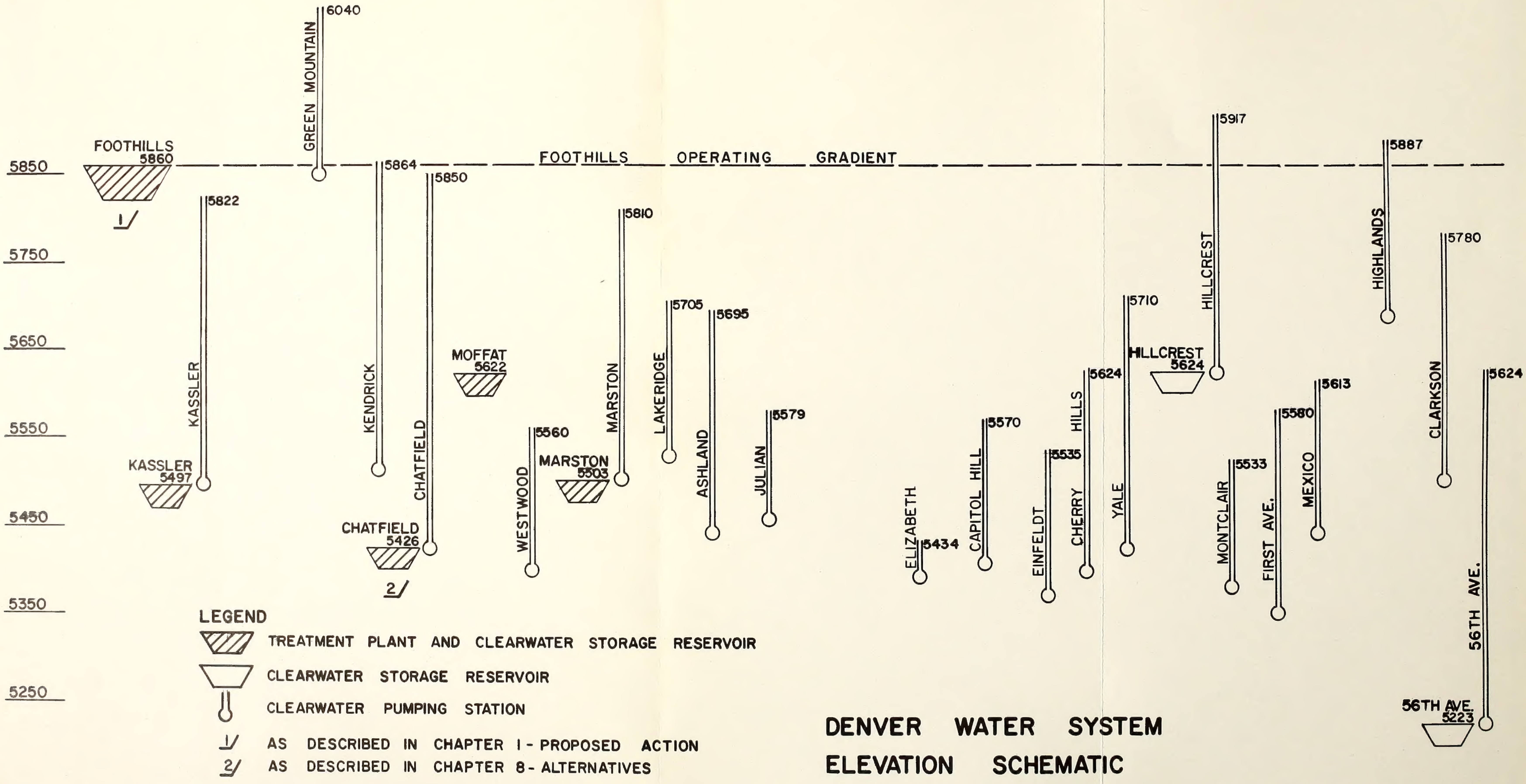
TABLE 1-6

SUMMARY OF PROJECT MATERIALS

	Initial 125 mgd unit	Expansion to 500 mgd	Total
Aggregate	300,000 tons	150,000 tons	450,000 tons
Cement	48,000 tons	25,000 tons	73,000 tons
Steel	10,000 tons	9,000 tons	19,000 tons
Water	90-100 acre-feet	90-100 acre-feet	180-200 acre-feet

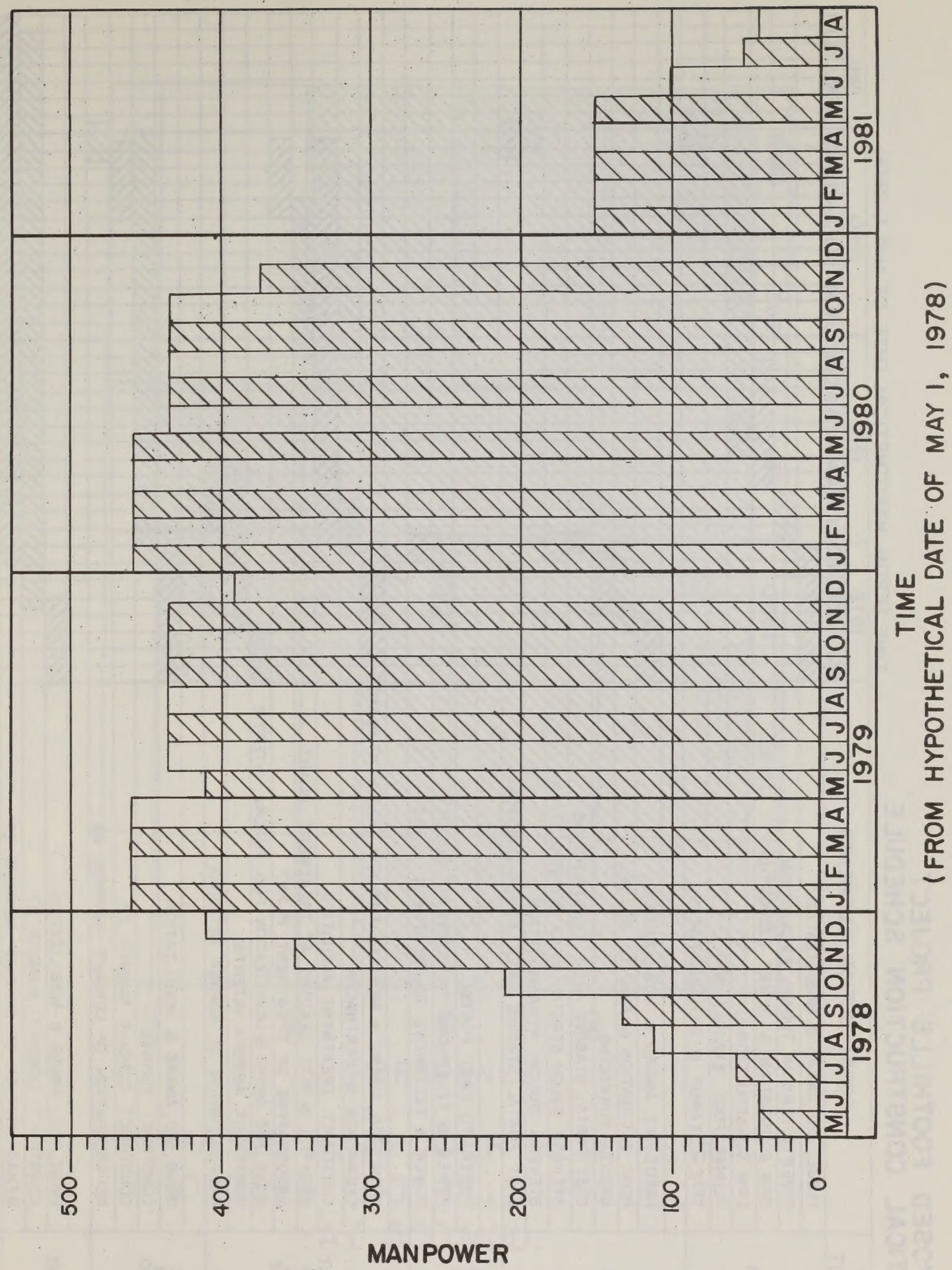
The construction of the first 125 mgd increment would employ as many as 460 persons working three eight-hour shifts seven days a week (Figure 1-2). For purposes of impact analysis, a probable construction schedule (Figure 1-3) was developed by the DWB from a hypothetical starting date of May 1, 1978.

The construction of the 500 mgd plant would employ as many as 190 persons working three eight-hour shifts seven days a week for more than six years (Figure 1-4). A construction schedule (Figure 1-5) would begin in 1986 and continue through 1998. As described in the Proposed Action section of this chapter, the year 2001 will be used to measure impacts.



DENVER WATER SYSTEM
ELEVATION SCHEMATIC

FIGURE 1-1



ESTIMATED MANPOWER REQUIREMENTS
PROPOSED FOOTHILLS PROJECT
AT 125 MGD.

FIGURE 1-2

PROPOSED FOOTHILLS PROJECT
HYPOTHETICAL CONSTRUCTION SCHEDULE

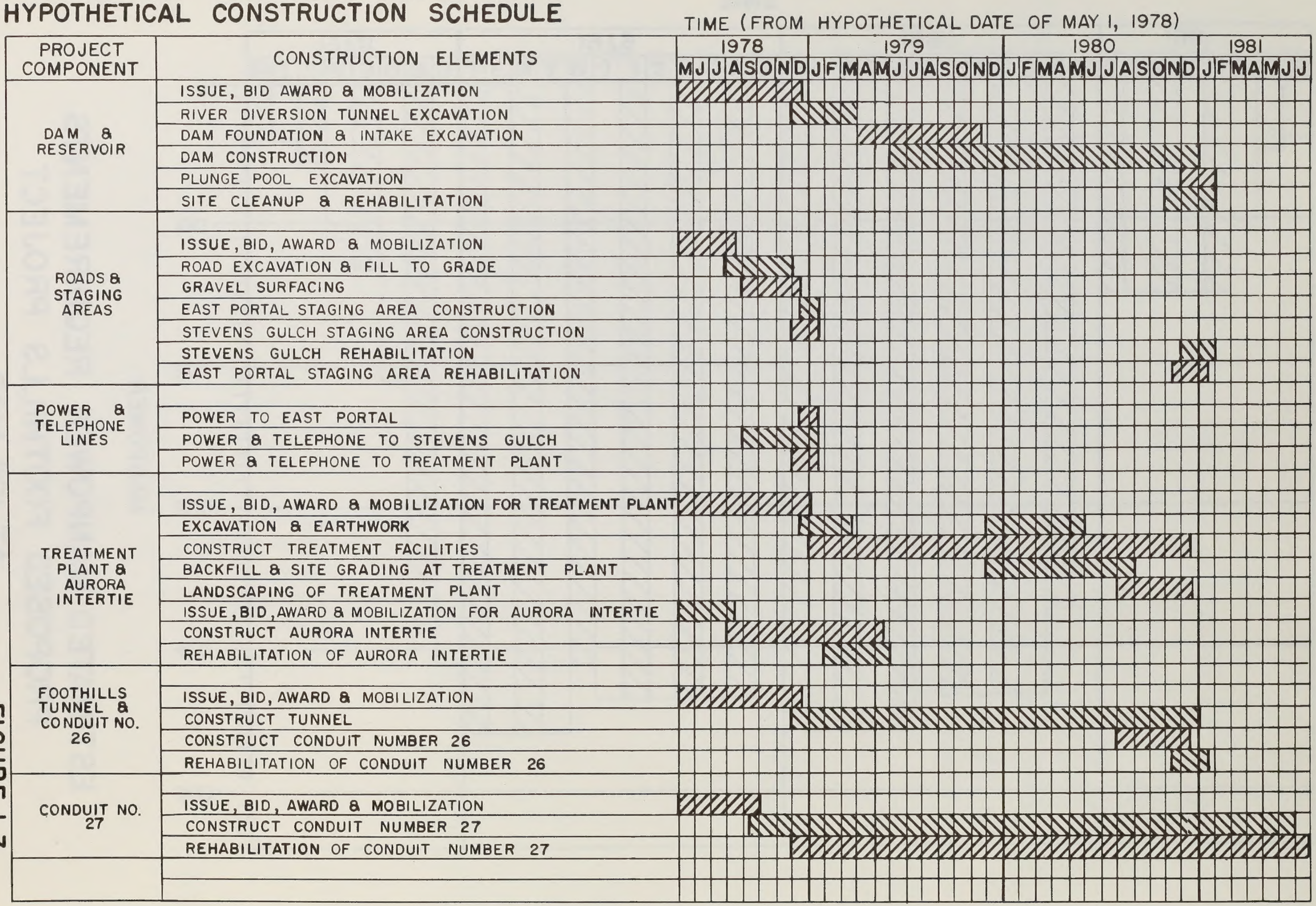
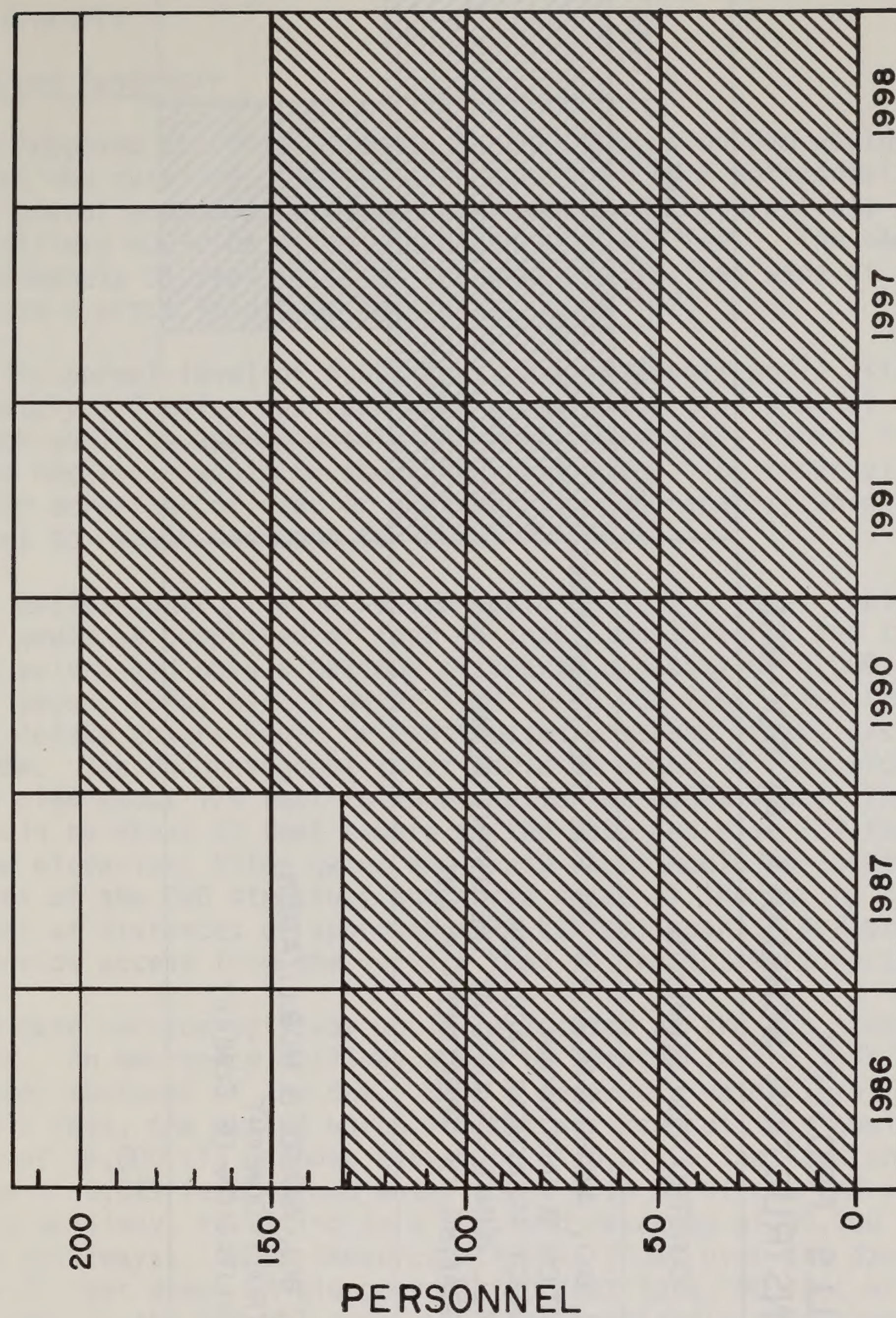


FIGURE 1-3



ESTIMATED MANPOWER REQUIREMENTS
PROPOSED FOOTHILLS PROJECT
AT 500 MGD.

FIGURE 1-4

PROPOSED FOOTHILLS PROJECT
HYPOTHETICAL CONSTRUCTION SCHEDULE AT 500 MGD.

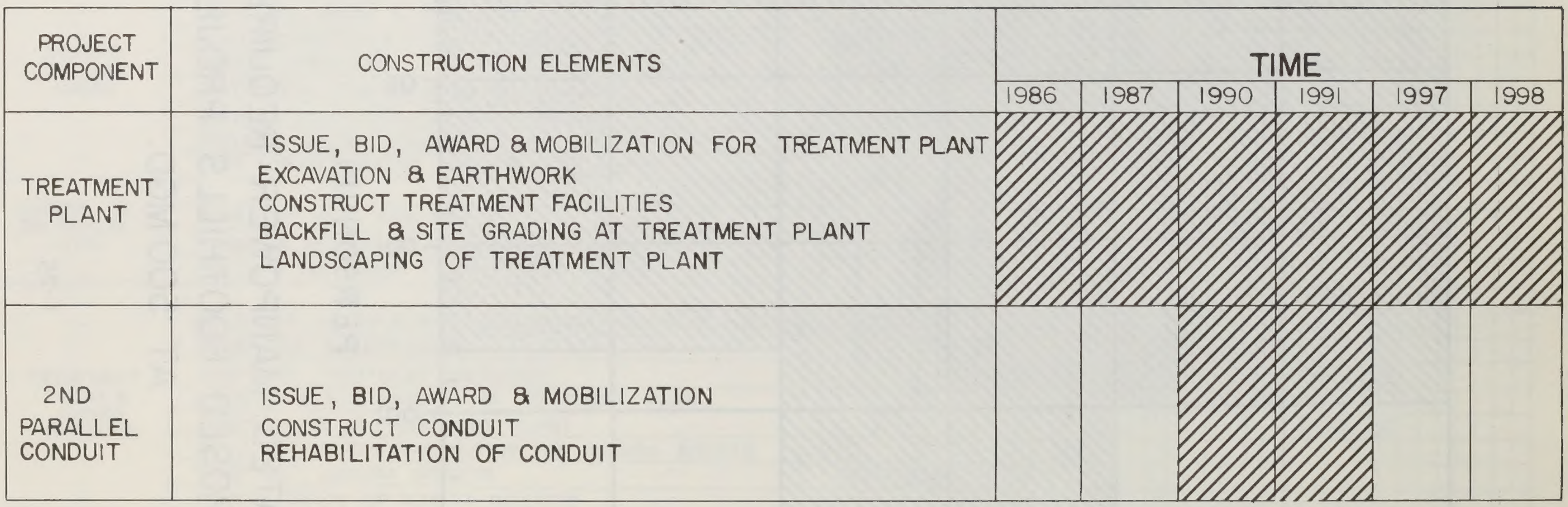


FIGURE I-5

Project Elements

Dam and Reservoir

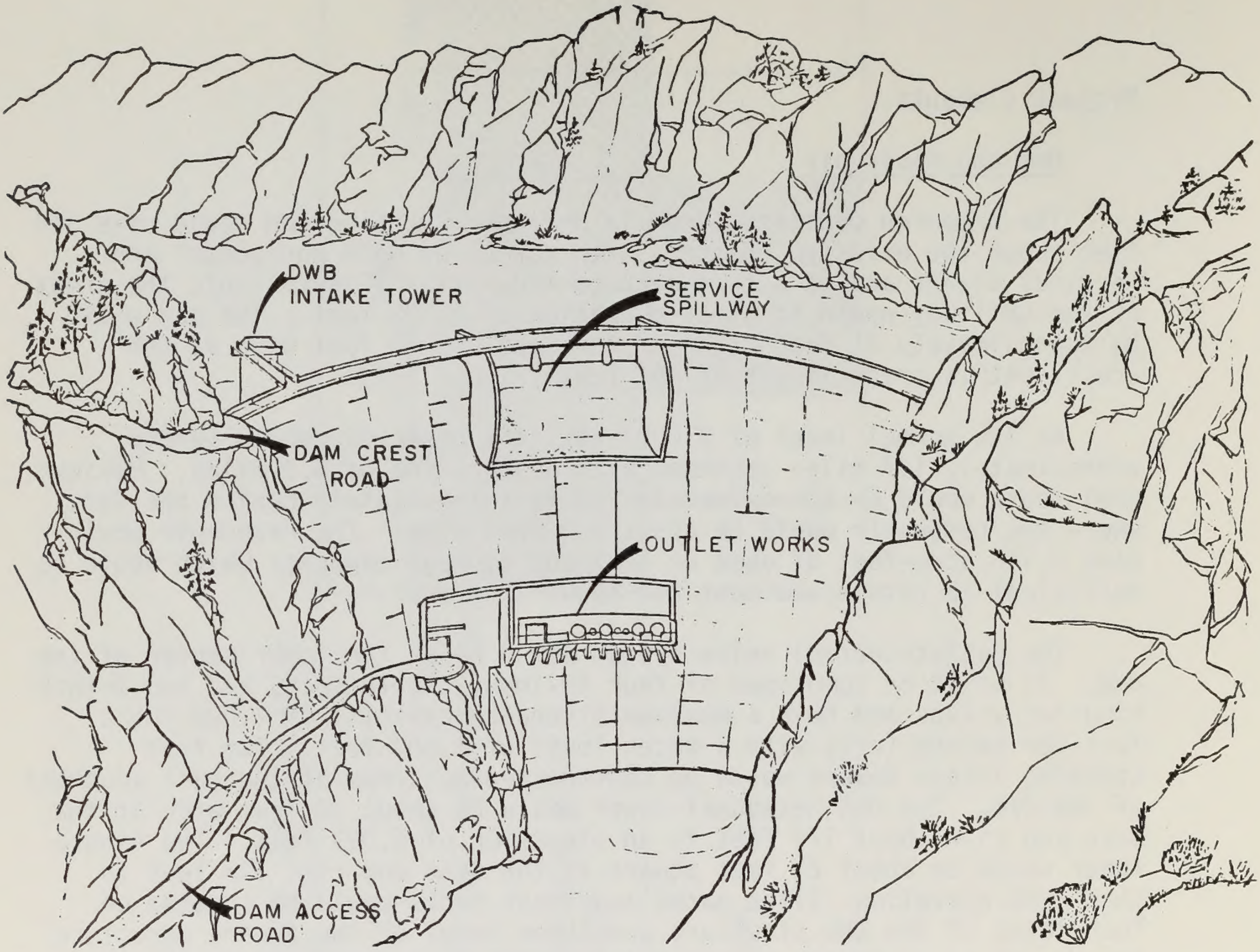
The proposed concrete Strontia Springs Diversion Dam would rise 243 feet above the existing channel, with curves on both horizontal and vertical planes and of a thin-arch configuration (Figure 1-6); the crest of the spillway would be at an elevation of 6,002 feet. The dam would be approximately 31 feet thick at the base and 10 feet wide at the crest, with a crest length of 601 feet (Figure 1-7).

At its normal level of 6,002 feet, the reservoir would extend approximately 1.7 miles upstream with a shoreline of 4.9 miles. Maximum pool depth would be approximately 240 feet immediately behind the dam, where the reservoir would be about 400 feet wide. The reservoir would have 2,110 acre-feet of dead or sediment storage capacity which would be sufficient to retain sediment for about 75 years.

The outlet-control valve system would be at the lower center of the dam. It would be comprised of four 48-inch, two 18-inch, and two 8-inch ring jet valves and have a maximum discharge capacity of 4,000 cubic feet per second (cfs) with a water level of 6,002 feet. Two free-standing intake towers would be constructed upstream of the east abutment of the dam. The DWB hexagonal tower would be about 35 feet wide at the base and rise about 179 feet to an elevation of 6,029 feet. The Aurora tower would be about 21 feet square at the base and rise 123 feet to that same elevation. Slide gates and trash racks would be located on four faces of the DWB structure and three faces of the Aurora structure and be set at distances of approximately 23 feet apart. A footbridge would provide access from the service road to the intake towers.

The main service spillway would be located at the top center of the structure. An emergency spillway would be located in the left (facing downstream) abutment of the dam. With a reservoir water level elevation of 6,012.5 feet, the outlet works and the service spillway would have a capacity of 16,000 cfs. Above elevation of 6,012.5 feet and up to an elevation of 6,029 feet, flood water would also be discharged over the emergency spillway, resulting in a combined capacity of 90,000 cfs from both the spillways. Under these conditions, flows over the dam crest would be 27 feet deep. A plunge pool 120 feet long, 90 feet wide, and 25 feet deep in the natural rock would be immediately downstream from the dam. A bridge over the center spillway would provide vehicle access across the crest of the dam to the emergency spillway.

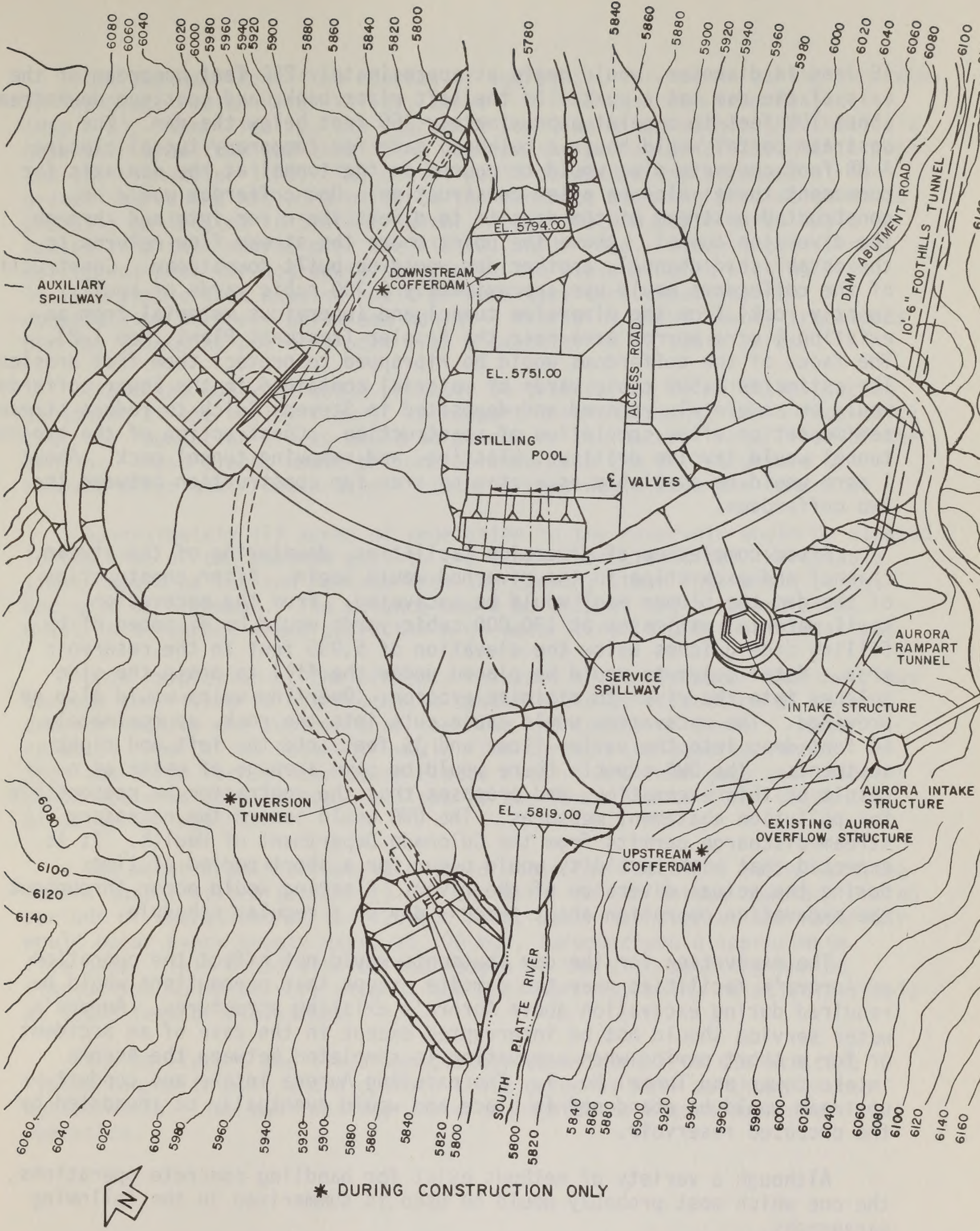
Because the river occupies most of the narrow valley, diversion facilities would have to be built before any foundation excavation could begin in the riverbed. The normal stream channel would be diverted through a temporary system involving a diversion tunnel and cofferdams (Figure 1-7). The tunnel and diversion system would be disigned to withstand 25 year flood flows and pass 4,440 cfs. Construction of the tunnel,



PROPOSED STRONTIA SPRINGS DAM & RESERVOIR

FIGURE I-6

PREPARED BY FOOTHILLS PROJECT CONSULTANTS



PROPOSED GENERAL LAYOUT STRONTIA SPRINGS DAM

FIGURE 1-7

18 feet in diameter, would begin at approximately 250 feet upstream of the axis of the dam, at a portal in the left river bank, and continue downstream about 700 feet to a point approximately 350 feet below the dam. The upstream portal would house a bulkhead gate for temporary tunnel closure. A 38-foot concrete plug would be poured in the tunnel at the dam axis for permanent tunnel closure after construction. One cofferdam would be constructed upstream of the damsite to divert the river into and through the diversion tunnel. Above the point where the stream flow returns to the established channel, another dam would be built downstream. Construction of the cofferdams would use approximately 6,700 cubic yards of spoil (mostly rock) from the diversion tunnel and impervious material from an existing 1 acre borrow area near the Kassler Treatment Plant (Map 1-2). The faces of the cofferdams would be riprapped to protect them from erosion. The estimated 1,500 cubic yards of material contained in the lower cofferdam would be completely removed and deposited in Stevens Gulch to reduce stream sedimentation after completion of construction. Construction of the bypass tunnel would involve drilling, blasting, and removing tunnel muck. About 1 acre would be available as a staging area for construction between the two cofferdams.

After completion of diversion facilities, dewatering of the stream channel and excavation in the riverbed would begin. After construction of the dam the plunge pool would be excavated. From the excavation, spoil material estimated at 130,000 cubic yards would be disposed of by filling side gulches below the elevation of 5,935 feet in the reservoir area. Metal culverts would be placed under the fill to drain the side gulches into the river to minimize erosion. Overflow weirs would also be provided. The excavation would cause cuts into the rock, approximately 60 feet deep into the valley floor and 35 feet into the left and right abutments. The DWB expects there would be some seepage of water as a result of this excavation, and proposes that the contractor be responsible for pollution abatement measures. The DWB would secure the necessary stream-discharge permits from the Colorado Department of Health. It is expected that high turbidity would occur for a short period of time during the actual diversion of the river. Blasting would occur throughout the excavation operation about twice a day on a regular schedule.

The excavation for the dam abutments would not affect the operation of Aurora's facilities near the damsite except that precautions would be required during excavation above Aurora's existing structures. Aurora's water service should not be interrupted except in the case of an accident or for a short period when excavation is completed between the Aurora intake tower and Tunnel No. 1. The existing Aurora intake and conduit upstream would be abandoned in place and would eventually be inundated by the proposed reservoir.

Although a variety of methods exist for handling concrete operations, the one which most probably would be used is summarized in the following paragraphs.

The DWB has identified sources of aggregate, for use in making concrete, in the South Platte River Valley, about 1 mile downstream from Kassler (Map 1-3). Specifically, the aggregate would be mined within the Chatfield Reservoir area from the zone lying between the perimeter of the static pool and the high-water line. The gravel would be washed and screened at the gravel source and hauled 8 miles to the concrete batching area which would probably be located in Stevens Gulch. About 109,000 cubic yards would be hauled from this source over the Platte Canyon road. Since there is not sufficient area for aggregate storage at the Stevens Gulch staging area, it is probable that hauling would be necessary throughout the dam construction period - seventeen months - averaging about twenty truckloads per day (assuming use of trucks with a capacity of 10 cubic yards).

The mixed concrete would probably be transferred to hoisting-placing equipment at the valley floor. To support this equipment, two 4-foot-thick concrete foundation blocks would be placed on the natural rock floor of the canyon. These blocks would be incorporated into the dam structure or removed after use. Cable-ways or tower cranes would move the concrete.

Approximately 117 acres of vegetation in the reservoir would be cleared in the area of the maximum pool to the 6,029-foot elevation. Marketable timber would be cut and removed from the canyon; other logs would be cut and sold as firewood. The balance would be chipped and disposed of as mulch in disturbed areas above the high-water line (6,029-foot elevation).

Upon completion of the project, releases of stored water and the flows through the rivers to the Foothills system would be a function of water demands made by the customers of the City and County of Denver. Water released from Dillon Reservoir would flow through the Roberts Tunnel into the North Fork of the South Platte River. A stream gage near Stevens Gulch would be used to measure flows in the South Platte River below the Strontia Springs Dam.

Raw water from the reservoir would enter the Foothills Tunnel and the Aurora tunnel system (existing) via the gates on the intake towers. During periods of operations at the 125-mgd rate, water turnover at the reservoir would occur every twenty days; at 500 mgd, turnover would approximate five days. This would also be the length of the silt-settling period. Fluctuation would be very slight, the pool normally being relatively stable at 6,002 feet of elevation.

The caretaker, who lives immediately downstream from the existing Platte Canyon intake, would operate these gates as well as those on the outlet works. The dam facility would be lighted to accommodate night operation.

Access Roads and Staging Areas

Access roads and staging areas are proposed to support the construction operation (Map 1-2). During construction, the existing access road in the South Platte Canyon would be closed to all uses not related to construction. The existing road from the Platte Canyon intake to Stevens Gulch, about 13,950 feet in length, would be improved to accommodate construction traffic. The road would have a 2 to 3 percent grade and a general roadway of 22 feet over a distance of about 13,900 feet. Typical road cross-sections are shown in Figure 1-8.

Only one crossing of the South Platte River would be necessary - at the location of the existing narrow gage railroad bridge. That structure would be replaced by a steel beam-concrete deck bridge with a 22-foot running surface employing the existing abutments. Plans call for the Keystone Bridge to be carefully dismantled, piece-marked, and stored at Kassler for future use as appropriate.

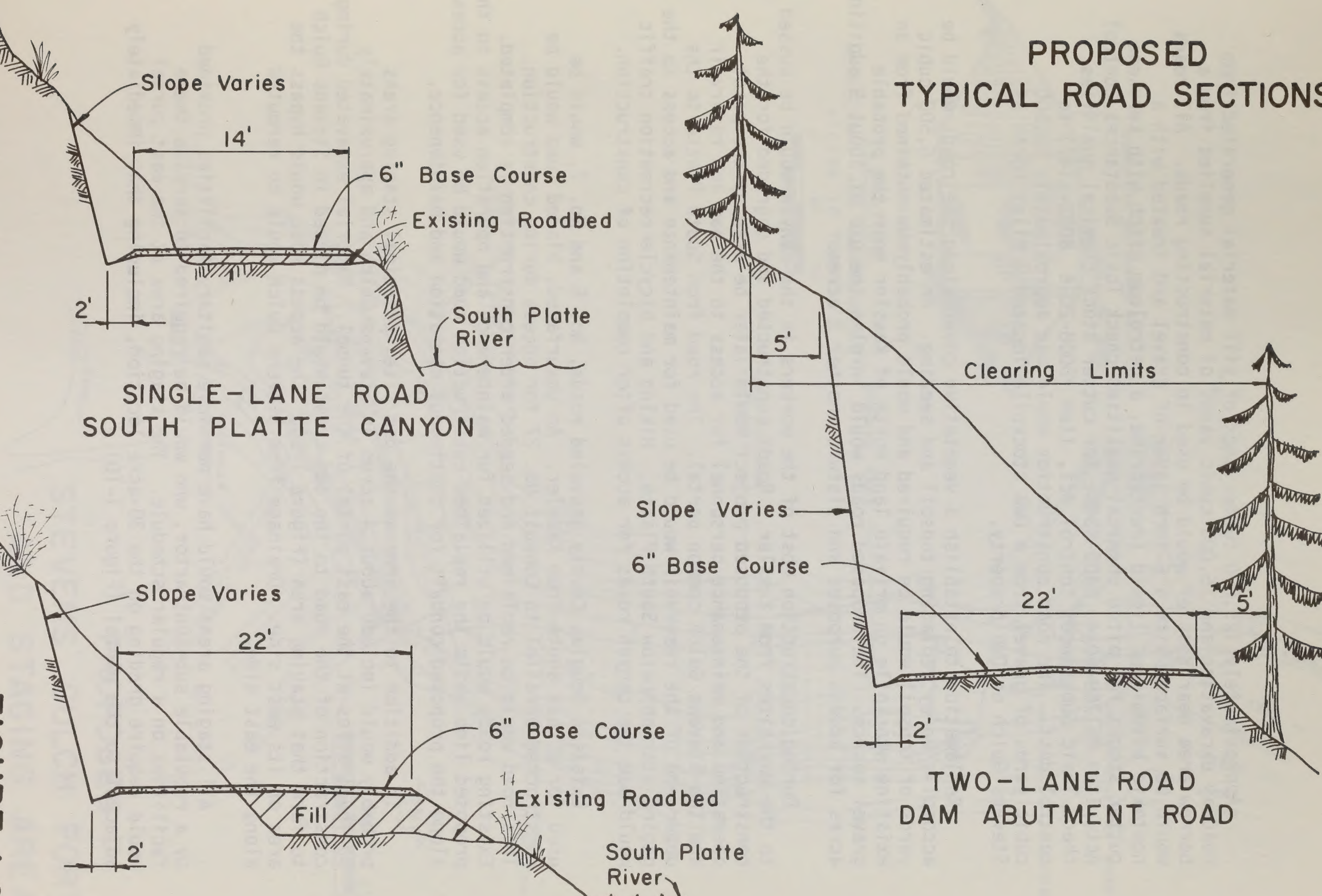
Culverts would be installed at all drainage crossings except at Mill Gulch and Stevens Gulch, where paved waterway sections would be placed. These sections would be located over culverts to allow passage of normal runoff. Additional fill material would be added to the existing roadway in the canyon, raising the roadbed a maximum of 5 feet, to reduce possible damage from flooding. The design of the canyon road as proposed does not include any road cuts or fills that are not absolutely necessary. However, some cuts and fills cannot be avoided. These areas are estimated at less than 5 acres; in these areas the DWB proposes to place topsoil on the fills and plant them with appropriate ground cover. The widening would require about 5 additional acres for the roadbed.

At Stevens Gulch the road would fork. The left fork would have a 22-foot roadway and would extend up and beyond Stevens Gulch 5,000 feet to the right abutment of the dam crest. This road would switch back about 2,000 feet up the gulch and contour back for another 3,000 feet at a grade of nearly 10 percent. That last 3,000 feet would require the only new road construction in the Platte Canyon. It would permanently displace approximately 2 acres and disturb an additional 2 acres.

The right fork from Stevens Gulch would have a 22-foot roadway and would follow the existing road along the river to the base of the dam site, a distance of about 1,500 feet. About 1 acre would be devoted to road widening. Rehabilitation would not be practical.

The existing road, which would be located in the dam and reservoir area and would later be inundated, would be maintained with only minimum upgrading. The existing road upstream from the proposed reservoir would be improved to provide a 13-foot roadway with turnouts over a distance of 6,400 feet, from the upstream end of the reservoir to the town of South Platte. This road would be used to transport some of the workers to the site to reduce traffic on the downstream road. This proposed improvement would involve widening only where possible, would require about 1 additional acre for roadway, and would also disturb about 1 acre which would be smoothed and seeded later.

PROPOSED TYPICAL ROAD SECTIONS



SINGLE-LANE ROAD
SOUTH PLATTE CANYON

TWO-LANE ROAD
DAM ABUTMENT ROAD

TWO-LANE ROAD
SOUTH PLATTE CANYON

FIGURE I-8

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

Approximately 125,000 cubic yards of fill material generated from roadway excavation and 15,000 cubic yards of material supplied from a borrow area near Kassler would be used in constructing roads. All roads would be surfaced with a 6-inch layer of gravel and treated with a nontoxic bituminous liquid (Pentaprime, a petroleum pitch with kerosene cutter stock; for pitch chemical qualities check Toxic Substances Control Act, Item *61789-60-4 B405-5588; for cutter stock chemical qualities check Toxic Substances Control Act, Item *8008-20-6 B032-5147) to control dust. The road construction would use approximately 12,500 cubic yards of gravel from a DWB stockpile located 3 miles north of Stevens Gulch on DWB property.

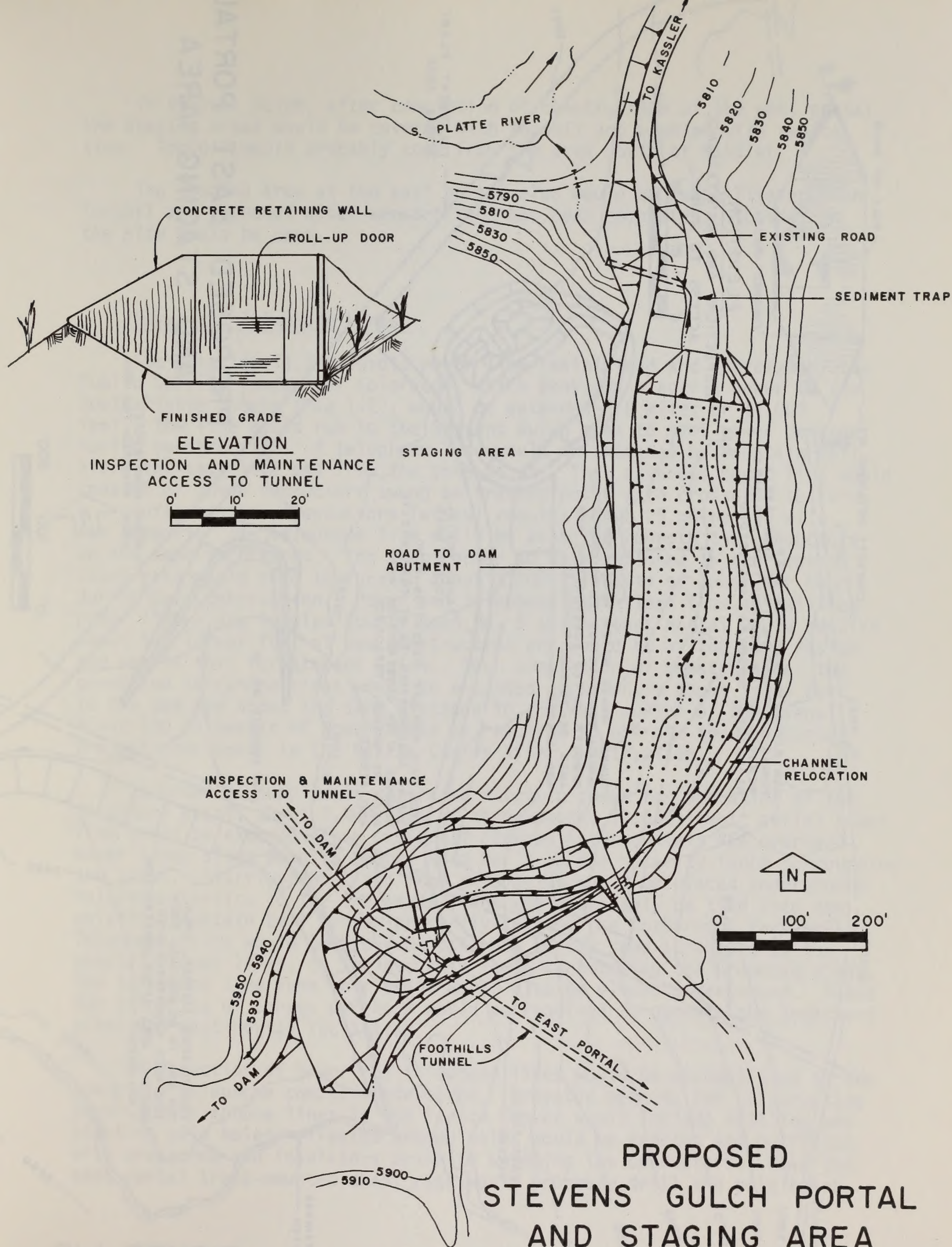
Reclamation to establish a vegetative cover along the roads would be accomplished by replacing topsoil and seeding. An estimated 6,500 cubic yards of topsoil would be required and would probably be obtained from an existing stockpile on private land north of Kassler near the probable gravel source. The proposed roads would involve the use of about 9 additional acres for access purposes and disturb another 8 acres.

During construction most of the workers in the canyon would be bussed to the worksites from Kassler. Roads constructed and upgraded for the construction of the proposed project would later be used by the plant operation and maintenance personnel for access to the dam and reservoir and the Stevens Gulch common portal. The road from South Platte to the upper end of the reservoir would be used for maintenance and access to the gaging station below South Platte. Hiking and bicycle recreation traffic would use the canyon roads for access after completion of construction.

Existing Douglas County graveled roads, No. 5 and No. 7, would be used for access south from Kassler. An unsurfaced, bladed road would be constructed parallel to Conduit No. 27 for access during construction. This road would be reclaimed and seeded after construction is completed. Existing roads would be utilized for maintenance and operation access to the proposed line while the reclaimed construction road would be used for access along the proposed conduit for continuous operation and maintenance.

In addition to the area at the dam site, principal staging areas probably would include about 4 acres in Stevens Gulch and approximately 30 level acres at the east portal of the tunnel. Material excavated during construction of the road to the dam crest would be placed in Stevens Gulch to form that staging area (Figure 1-9). The access road would bypass the area on its west side. Drainage from Stevens Gulch would be rerouted along the east side.

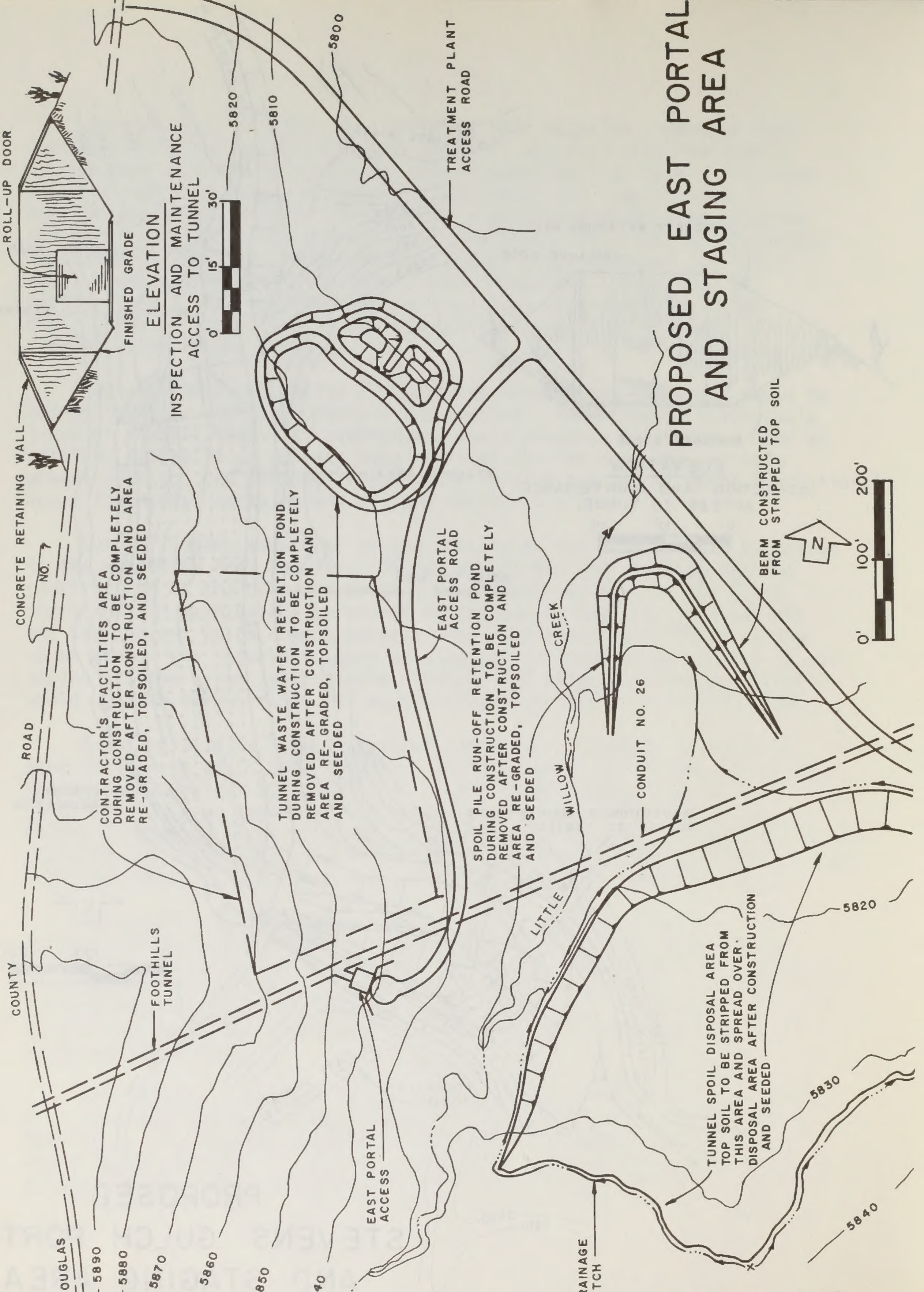
All staging areas would have portable sanitary facilities provided by a reputable sub-contractor, who would be required to service these facilities on a regular schedule. The staging area at the east portal would require grading on the 30-acre location, including that immediately adjacent to the portal (Figure 1-10).



PROPOSED
STEVENS GULCH PORTAL
AND STAGING AREA

FIGURE 1-9

PREPARED BY FOOTHILLS PROJECT CONSULTANTS



PROPOSED EAST PORTAL AND STAGING AREA

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

FIGURE 1-10

In Stevens Gulch, after completion of construction of the west portal the staging areas would be covered with topsoil and planted with vegetation. Topsoil would probably come from the area north of Kassler.

The staging area at the east portal also would be rehabilitated with topsoil and reseeded after construction has been completed. Topsoil on the site would be used.

Power and Telephone Lines

The existing 13.2-kilovolt power line (maintained and operated by the Public Service Company of Colorado), which provides electric power to the South Platte intake (Map 1-2), would be extended 2.8 miles or 14,800 feet. The line would run to the Stevens Gulch area to meet power demands during construction. A telephone line would be extended by Mountain Bell along the same line and from the same point. This extended power line would consist of three conductors swung on treated poles with crossarms to form a T configuration. Conductors (wires) require about 25 poles per mile for support. The telephone line would be attached beneath the conductors on the same structures. The transformer to be positioned in the Stevens Gulch area would need to furnish about 2,000 kilowatts of power per hour during dam construction. Power and telephone extensions from an existing power line along Douglas County Road No. 5 to the east portal would require about 500 linear feet of new construction and would be of the same design and use as that for Stevens Gulch. Upon completion of construction, the power and telephone lines would be extended permanently about 1,300 feet to the dam and about the same distance to the west portal of the tunnel. About 100 kilowatts of power would be required to operate these proposed project components in the Platte Canyon after construction.

In order to supplement generated electric power for operation of the treatment plant, about 2,000 feet of three-phase, 12.6-kilovolt aerial power line would be extended from presently planned Intermountain REA overhead power lines along Douglas County Road No. 5 to the security fence surrounding the plant. Distribution lines from this point would be placed underground. Telephone service to the treatment plant would probably be tied into the existing Mountain Bell system presently serving the Roxborough Park area. Telephone lines would probably be attached to the same structure as the electric power lines, to the security fence surrounding the proposed plant. The telephone line from this point would also be placed underground. About 900 kilowatts of energy per hour would be required to operate the treatment plant and west portal facilities.

Construction of power and telephone lines would be accomplished by the power and telephone companies involved. Probable methods for constructing power and telephone lines in the Platte Canyon would include drilling and blasting pole holes. Treated wooden poles would be erected and outfitted with crossarms and insulators prior to swinging the conductors. Near the east portal truck-mounted drill rigs would probably drill the pole holes.

Tunnel

The proposed Foothills Tunnel, 17,967 feet long and 10.5 feet in diameter, would be capable of passing a maximum flow of 710 mgd.

The system would begin as concrete-lined tunnel, 1,705 feet long, from the bottom of the intake structure behind the diversion dam to the Stevens Gulch common portal where it would emerge for 170 feet as a conduit, buried except for vehicle access (Figure 1-9). From Stevens Gulch, a concrete-lined tunnel would extend about 16,092 feet to the east portal, located between Douglas County Road No. 7 and Little Willow Creek. A surge chamber would be located in the tunnel about 2,900 feet west of the east portal, vented by a 48-inch pipe which would extend 6 feet above ground.

The east end of the tunnel would be covered by a pressure-competent, reinforced concrete structure and would be housed in a 24 x 24 foot concrete maintenance and access building. A 10 x 12 foot door would provide vehicular access to the tunnel. Permanent power would be provided to both portals.

Construction of the proposed tunnel system would begin at the Stevens Gulch common portal and progress simultaneously in two directions: west toward the diversion dam and northeast toward the east portal. At the same time excavation at the east portal would be initiated, proceeding toward Stevens Gulch. Tunnel construction from Stevens Gulch probably would be performed initially by drilling and blasting of the tunnel headings. Blasting would take place once or twice a day, on a scheduled basis.

The material from the excavation of the proposed Foothills Tunnel at the common portal in Stevens Gulch would be deposited in a valley or draw approximately 400 feet from the portal along the road to the top of the dam. More material would probably be generated than could be stored at this site and would be hauled to another disposal site in the reservoir area.

All water discharged from the Stevens Gulch portal and east portal would be treated as required by a Colorado Department of Health discharge permit to make it acceptable for discharge into the South Platte River. As proposed by the DWB, the treatment of all tunnel waste water and disposal waste pile runoff would be the responsibility of the contractor after first obtaining a stream discharge permit. The treatment method would probably make use of the retention ponds described below.

Prior to actual tunnel excavation, approximately 3,000 cubic yards would be excavated to provide a vertical face for the tunnel headings at the east portal and at both portals in Stevens Gulch. In addition, approximately 5,000 cubic yards of material would be excavated in the Stevens Gulch portals for retention ponds and to provide level areas for the contractor's plant, offices, and equipment (Figure 1-9). At the east portal approximately 28,000 cubic yards of material would be excavated to construct retention ponds and

water collection systems and to level areas for the contractor's plant, offices, and equipment (Figure 1-10).

The total tunnel project would entail the excavation of 102,000 cubic yards of in-place material that could possibly swell upon excavation and increase to a total waste volume of approximately 143,000 cubic yards. It is assumed that 40 percent of the material generated would be from the common portal at Stevens Gulch and 60 percent of the material generated would be at the east portal.

Most of the excavated material that would be generated from the tunnel operation at the east portal would be deposited in prescribed areas along Little Willow Creek (Figure 1-10). Prior to receiving the excavated materials these prescribed areas would be stripped of topsoil. The topsoil would then be stock-piled for eventual covering of the tunnel waste material. During the construction period, the toe of the slopes of the deposited material would have a cutoff trench to prevent any drainage from the excavated material entering Little Willow Creek. A portion of this material would be used to build the access road to the site of the proposed treatment plant.

Tunnel construction initiated from the east portal would also require drilling and blasting.

After excavation, the tunnels would be lined with steel reinforcement and conventionally placed concrete, averaging 8 inches in thickness. Concrete batch plants would be needed at either or both portal staging areas.

After construction, the structure in Stevens Gulch would be backfilled, covered with topsoil and seeded. The completed structure at the east portal would be shaped to original contour with material from the staging area excavation. The area would be landscaped and seeded.

After completion of the proposed Foothills Project, water would enter the tunnel at its western terminus directly below the intake structure behind Strontia Springs Dam. Selective draw-off from the reservoir would be made possible by the slide gates at various elevations on the intake tower. Trash racks would prevent large objects from entering the tunnel.

The water would flow through the tunnel, by gravity, to the treatment plant, protected by a surge chamber. This control chamber, or pocket, would prevent damage to the tunnel lining from a hydraulic surge, or water hammer, which is produced by changes in the rate of flow.

Maintenance crews could enter the structure at Stevens Gulch and the east portal with motorized vehicles via the service doors for routine inspections and for needed repair of the tunnel.

Treatment Plant Complex

Conduit No. 26, a buried pipeline 10.5 feet in diameter, would be connected to the east portal of the proposed Foothills Tunnel. The line would extend 1,721 feet in an easterly direction to the proposed treatment plant. The undercrossing at Little Willow Creek would be protected by a concrete saddle. In addition, one conduit of 54 inches and 60 inches diameter and 2,450 and 1,500 feet in length would connect to the Aurora Rampart Reservoir.

Access roads and 25 above ground and nine buried structures would occupy about 65 acres at the proposed 125 mgd treatment plant (Map 1-7). A septic tank and drainfield system would be constructed on the site for disposal of sanitary waste during plant operation. The plant would be designed to treat 125 mgd initially, but the design would facilitate expansion to a maximum capacity of 500 mgd. When the 500 mgd expansion of the Foothills plant is built, thirty-six above ground and fourteen buried structures would be added (Map 1-8).

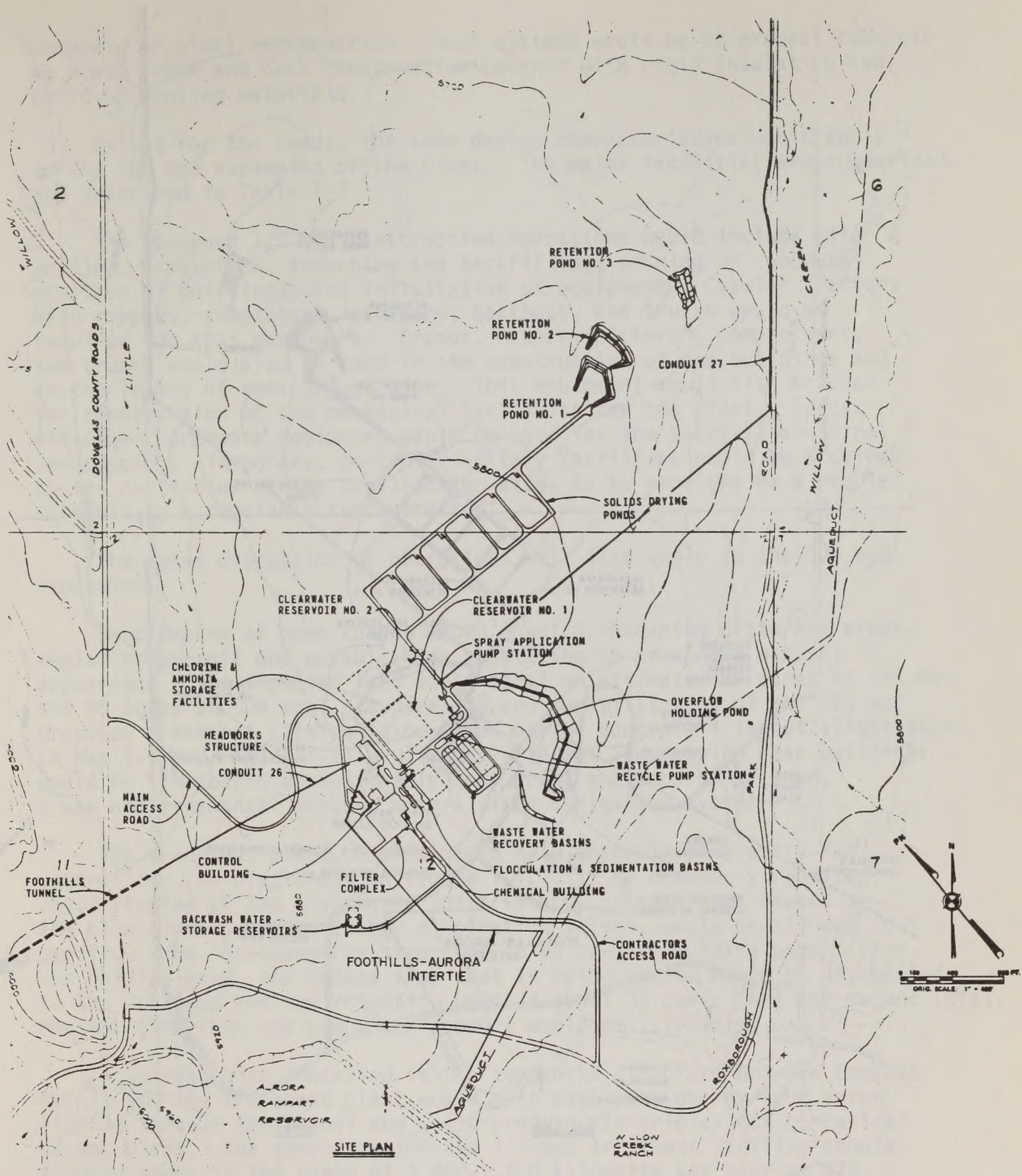
During construction of the 125 mgd plant, heavy equipment would excavate for the structures that are to be buried and would grade the site. All of the excavated material would be employed; a portion of it would be used for fill or backfill, part for construction of earthen ponds, and part for access road construction. A 3,700-foot asphalt paved plant access road with a 24-foot roadway would provide permanent access to the site from the west, crossing Little Willow Creek north of the east portal. There would be disturbance to about six acres of land. A 2,600-foot crushed rock-surfaced road with a 28-foot roadway would provide access from Roxborough Road in the south. This would be used for construction activities.

A chainlink fence six feet high with three strands of barbed wire would enclose the treatment plant area. A remote control gate would be installed at the entrance to the plant.

In its approach to the proposed plant, the plant access road would divide into two roads. One would lead to the chemical building as well as to an employees' parking lot; the other would lead to a visitor parking area at the control building.

Preparation of footings would involve 5 to 40 feet of excavation so that foundations would rest on suitable material. Excavations for footings would be backfilled and compacted with granular material from on-site excavations.

Portions of all structures below finish grade would be constructed of poured-in-place concrete. Above-grade portions of structures would be constructed primarily of precast exposed aggregate panels, or poured-in-place, textured, colored concrete. Columns and frameworks for support of wall panels and roof systems would be of poured-in-place



N

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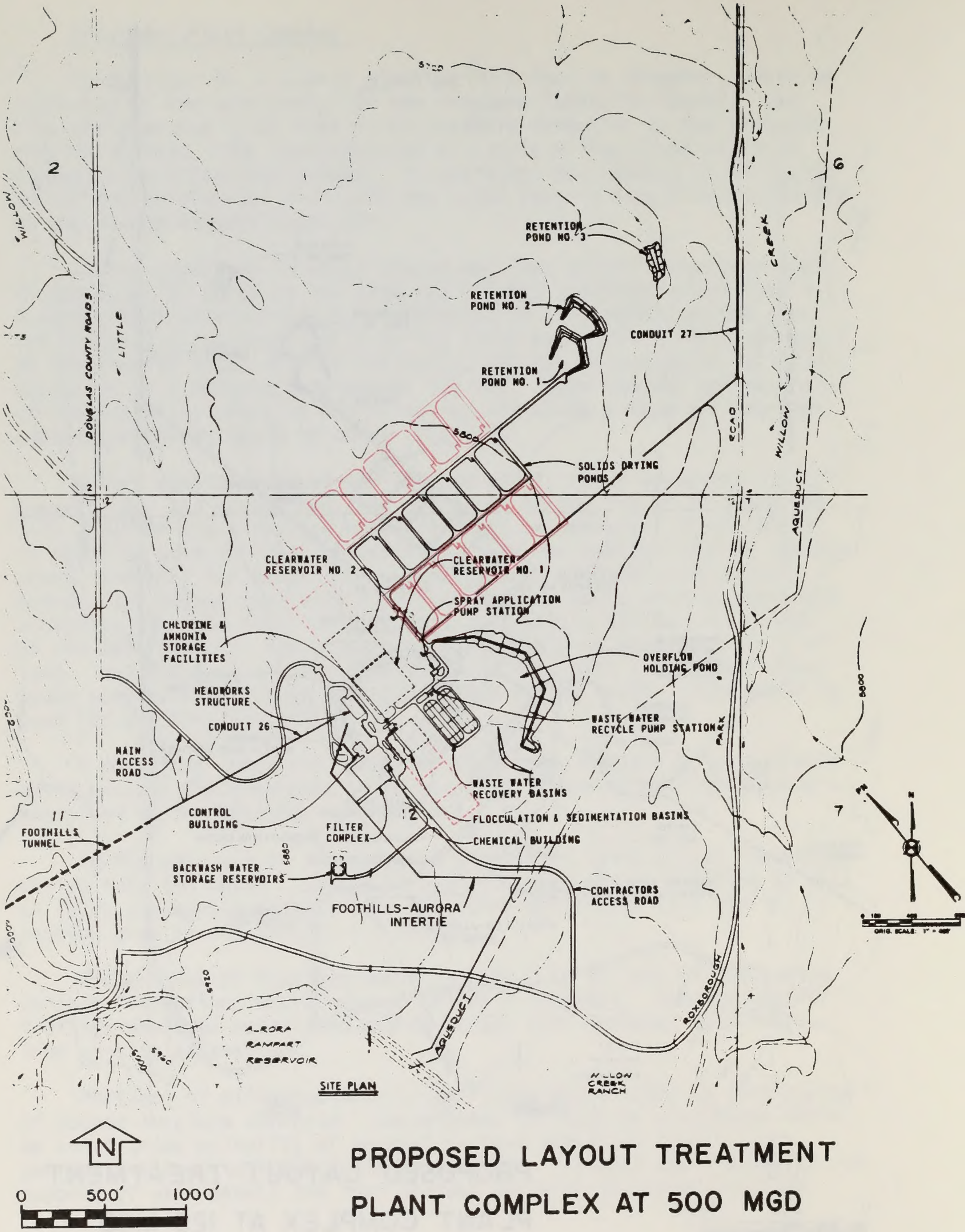
PROPOSED LAYOUT TREATMENT PLANT COMPLEX AT 125 MGD

MAP I-7

PREPARED BY FOOTHILLS PROJECT CONSULTANTS



PROPOSED LAYOUT TREATMENT PLANT COMPLEX AT 500 MGD

MAP I-8

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

concrete or steel construction. Roof systems would be of precast concrete on steel frame and deck construction covered with rigid insulation and built-up roofing materials.

Except for the roads, the same design characteristics would apply to the 500 mgd expansion of the plant. The major facilities are summarized and described in Table 1-7.

The proposed 125 mgd construction operations would include site grading, excavation, trenching and backfilling, pouring of concrete, erection of buildings, and installation of equipment. Crawler tractors with rippers, compactors, scrapers, backhoes, and trucks would be required for this earthwork. Cranes, "cherry pickers", compressors, and trucks would also be used in the construction of the buildings and in the laying of underground pipe. This equipment would also be used for construction of the mechanical facilities for the plant. Trucks and other earthwork equipment would be used for the backfill and final landscaping. Temporary, portable sanitary facilities would be provided by the contractor on the construction site, to be serviced on a regular schedule by a reputable subcontractor.

The above discussion of operations will also apply to the 500 mgd expansion.

Landscaping of open spaces would involve reshaping disturbed areas, replacing topsoil and establishing vegetation to provide a natural appearance. The impacted land would total an estimated 80 acres at 125 mgd and 90 acres at 500 mgd. Landscaping and rehabilitation of the 125 mgd proposed treatment site would be based on the conceptual layout illustrated in Map 1-9 and Figure 1-11. Ultimately formal landscaping near buildings would be limited to approximately four acres and consist of lawn, trees and ornamental shrubs, with a fixed irrigation system.

The treatment plant complex would rely entirely on gravity-fed water flows, as diagrammed in Figure 1-12. If an emergency required rapid closing of the plant's influent valves, excess flow, caused by the slow closing of the energy dissipation valves, would be allowed to overflow from the headworks structure to an on-site holding pond. From the holding pond, the excess flow that is being stored would be discharged to the drainage and low retention pond at about 35 cubic feet per second (cfs). Maximum flow from the raw water conduit would be 1,160 cfs.

A hydroturbine installed in the headworks structure between Conduit No. 26 and the treatment plant would help dissipate energy from water flowing through the tunnel and would produce electricity for operation of the plant. The generator for the 125-mgd treatment facility should produce power in the range of 1,050-1,600 kilowatts per hour at 125 mgd and 2,200-4,700 kilowatts at 500 mgd, depending upon flow through the filter plant. Using the mean production per hour of 1,325 kilowatts at 125 mgd, 3,262 kilowatts at 500 mgd, 24 hours per day, 365 days per

TABLE 1-7

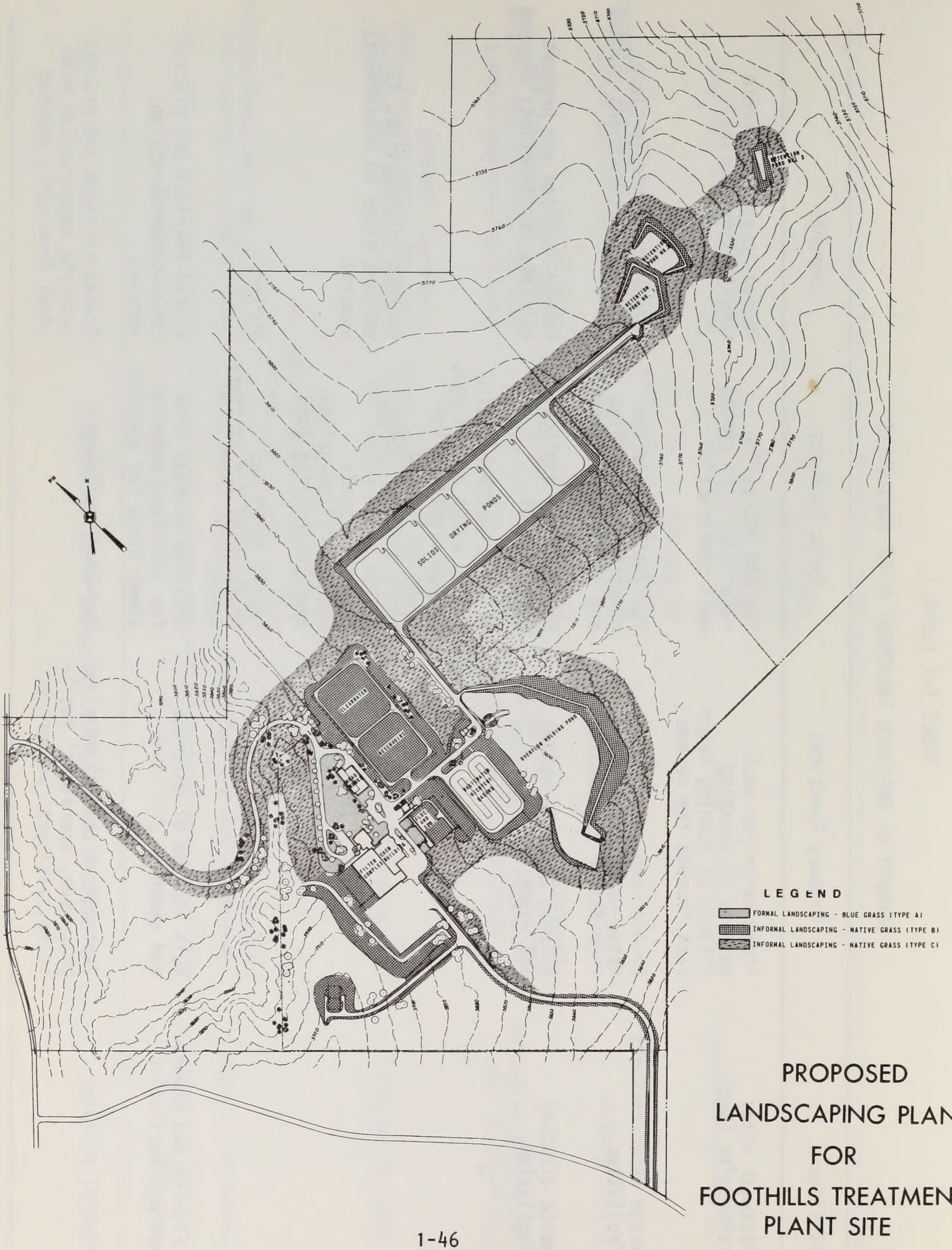
SUMMARY OF PROPOSED TREATMENT PLANT FACILITIES

Facility	Primary Functions	Basic Features	Comments
Headworks structure	Generate power and dissipate energy	One hydroturbine with parallel energy dissipating valves for occasional by-passing at 125, a second hydroturbine at 500 mgd	Poured-in-place and precast concrete construction; exposed
Chemical building	Store and feed chemicals	Storage and feed facilities for all chemicals except storage of chlorine and ammonia	Poured-in-place and precast concrete construction, steel framework; exposed
Flocculation and sedimentation basins	Flocculate or draw solid particles together and settle suspended solids in the water	Four parallel basins at 125 mgd, 12 additional parallel basins at 500 mgd	Poured-in-lace and precast concrete construction; buried except for equipment and gate house
Filter Complex	Filter the water	Eight parallel filters at 125 mgd, 24 additional parallel filters at 500 mgd	Poured-in-place and precast concrete construction; exposed
Clearwater reservoirs (two)	Store treated water	Two 25-million-gallon reservoirs at 125 mgd, 2 additional 25-million-gallon reservoirs at 500 mgd	Poured-in-place concrete construction; buried

TABLE 1-7 (cont.)

SUMMARY OF PROPOSED TREATMENT PLANT FACILITIES

Facility	Primary Functions	Basic Features	Comments
Backwash water reservoirs (two)	Store water for back-washing or cleaning filters by running water back through the system	Two 500,000-gallon reservoirs with common well construction	Poured-in-place concrete construction; buried
Waste water recovery facilities	Recover and recycle waste water primarily from filter backwashing	Two 2-million-gallon concrete-lined basins and recycle pump stations	Primarily poured-in-place concrete construction; exposed
Waste disposal facilities	Dispose of waste waters and waste solids	Solids spray application pump station	Poured-in-place and precast concrete construction; exposed
		-Six sand-bottomed solid drying ponds at 125 mgd, 12 additional drying ponds at 500 mgd -Three 0.75-million-gallon waste water retention ponds -One 12-million-gallon overflow holding pond	Earthen construction, 33 percent slope on embankments; exposed
		Septic tanks and drainfields for sanitary wastes	Buried
Chlorine and ammonia storage facilities	Bulk storage of chlorine and ammonia	Enclosed storage area for chlorine, exterior steel tanks for ammonia	Poured-in-place and precast concrete construction; exposed
Control building	Centralized control of plant processes, operators' facil-ities, visitors' center	Two-level building	Poured-in-place and precast concrete construction with steel framework; exposed



PROPOSED LANDSCAPING PLAN FOR FOOTHILLS TREATMENT PLANT SITE

MAP 1-9

PREPARED BY FOOTHILLS PROJECT CONSULTANTS


FOOTHILLS TREATMENT PLANT
DENVER BOARD OF WATER COMMISSIONERS
FOOTHILLS PROJECT CONSULTANTS: CH2M HILL · DMJM/PHILLIPS·REISTER · HARZA ENGINEERING CO.

FIGURE I-11

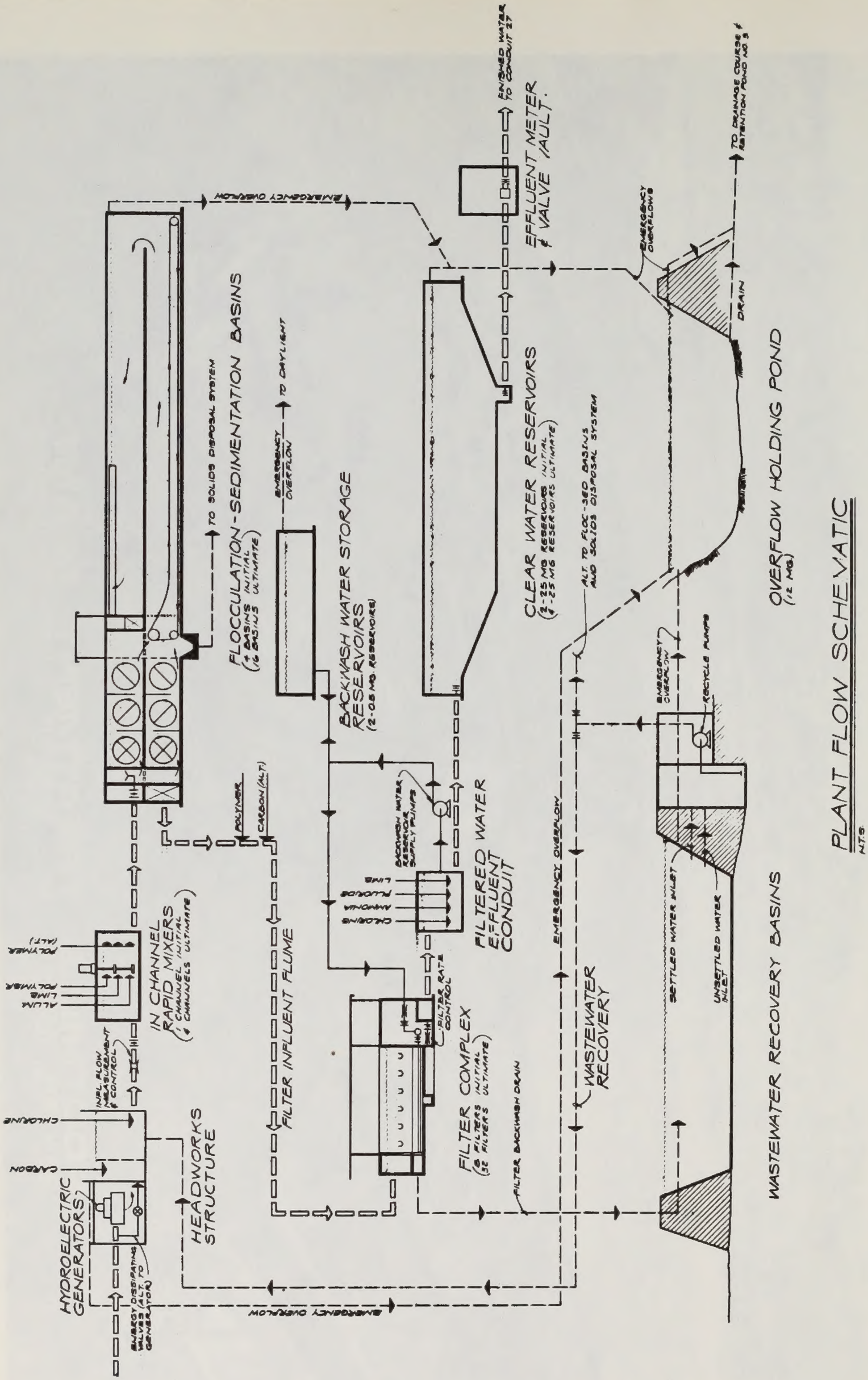


FIGURE 1-12

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

year, the average annual power production would be approximately 11 million kilowatt-hours at 125 mgd and 78 million kilowatt-hours at 500 mgd. With filter plant power consumption of eight million kilowatt-hours at 125 mgd, there would be a surplus of three million kilowatt-hours of electrical energy for sale annually. At 500 mgd, the filter plant would consume 13 million kilowatt-hours, with a surplus of 65 million kilowatt-hours for sale. Additional power lines would not be necessary to distribute excess generated power.

The proposed Foothills Plant would be geared for complete treatment, including coagulation, sedimentation, filtration, and disinfection. Water quality goals proposed for the plant are shown in Table 1-8. Coagulation using liquid alum or polymers as the coagulant and additional polymers as coagulant aids would be the main treatment for removal of color and turbidity. Prechlorination is proposed for efficient pretreatment and filter operation. This treatment would also assist in removing excess iron and manganese.

To improve taste and odor and to combat effects of organics and other contaminants, activated carbon would be provided for application at various points such as at the headworks and before the filters. Finally, post-chlorination with the aid of ammonia would be provided for maintaining the desired disinfectant residuals in the treated water. In addition, facilities would be provided for feeding postlime, for pH adjustment and corrosion control. Space would be provided for adding fluoride to supplement the amounts naturally occurring in the water supply, when determined to be necessary by the Colorado Department of Health.

Table 1-9 is a summary of various chemicals which would be used in the proposed treatment process with their form and method of delivery described. Bulk delivery and storage of chemicals are proposed where feasible. Approximately two weeks of storage under normal operating conditions is projected. The chemical building would house all chemicals except chlorine and ammonia; they would be handled in a detached structure for safety.

Liquid alum would be delivered to the plant in tank trucks equipped with self-contained pneumatic systems for transferring the chemical to the fixed storage tanks in the chemical building. Liquid polymer would be delivered in similar tank trucks. Lime would be delivered in the form of pebble quicklime by hopper-bottomed trucks; they would have self-contained pneumatic conveying equipment to blow the lime into the storage hoppers.

Bulk delivery and storage of chlorine in 17-ton tank trailers are proposed for the treatment plant. The storage would be remote from the main chemical building, in a separate enclosed building, to reduce hazard potential. Aqueous ammonia would be delivered in tank trucks and transferred into adjacent welded steel ground-level tanks.

TABLE 1-8

PROPOSED WATER QUALITY STANDARDS 1/

	Denver Goals	Public Health Standards	AWWA 2/ Goals
Physical factors			
Color	3.0*	15.0	3.0
Nonfilterable (suspended) residue	0.1	0.1	0.1
Odor	0*	3.0	0.0
Taste	0*	-	0.0
Turbidity	0.3*	1.0	0.1
Chemical factors			
Alkalinity	(Stable to 0.1)	-	-
Aluminum	0.10	-	0.05
Ammonia	0.01	0.01	-
Arsenic	0.05	0.1	-
Barium	1.0	1.0	-
Boron	1.0	1.0	-
Cadmium	0.01	0.01	-
Carbon chloroform extract	0.04	0.7	0.04
Chloride	50.0	250.0	-
Chromium	0.05	0.05	-
Copper	0.20	1.0	0.2
Cyanide	0.01	0.2	-
Fluoride	1.0	2.5	-
Hardness	(80-100 range)	-	(80-100)
Iron	0.1	0.3	0.05
Lead	0.05	0.05	-
Manganese	0.05	0.05	0.01
Mercury	0.001	0.002	-
Methylene blue active substances	0.2	0.5	0.2
Nitrates plus nitrates	10.0	10.0	-
pH	7.2-8.0*	6.0-8.5	-
Phenols	0.001	-	-
Phosphorus (total)	0.50	-	-
Selenium	0.01	0.01	-
Silver	0.05	0.05	-
Sulfates	100.0	250.0	-
Total dissolved residue	200.0	-	-
Zinc	1.0	5.0	1.0
Biological factors			
Macroscopic nuisance organisms/ liter	0.0	0.0	0
Coliform/100 ml	0.1	1.0	0
Fecal coliform/100 ml	0.0	0.2	0
Radiological factors			
Gross alpha picocuries/liter	10.0	0.5	-
Gross beta picocuries/liter	100.0	5	-

1/ This table was originally Table 3-3 in the Foothills Study Preliminary by Denver Water Board. (Standards are expressed in milligrams per liter or units(*).)
2/ American Water Work Association

TABLE 1-9

CHEMICALS TO BE USED IN PROPOSED TREATMENT PLANT AND METHODS OF PROPOSED DELIVERY AND STORAGE

Chemical	Form & Delivery	Frequency of Delivery 125 mgd	Frequency of Delivery 500 mgd	Hazards and Precautions
Alum	Liquid; truck	5 days	1 day	Acid spill; drains provided
Polymer	Liquid; tank truck	50 days	6 days	Mild acid
Lime	Pebble, bulk; truck	5 days	1 day	None
Chlorine	Compressed gas; tank trailer	16 days	2 days	Toxic; isolated, ventilated leak detection, alarm
Ammonia	Aqua (liquid); tank truck	30 days	3 days	Toxic; isolated, ventilated
Carbon	Dry powder, bulk; truck	40 days	5 days	None
Fluoride	(Will not be used initially; provision for fluoride application will be made with use and frequency of delivery as established by the Colorado Department of Health.)			None

Activated carbon would be delivered in bulk form by hopper-bottomed trailers equipped with pneumatic conveying equipment to facilitate unloading. To eliminate any dusting problem, the carbon would be delivered through a sealed connection from the trailer to the covered slurry tanks. Sodium silico-fluoride, when used, would be delivered in bulk form and pneumatically conveyed into storage hoppers. A scrubber would provide for removal of entrained dust from the transport air and return of the dust to the tanks.

During normal operation, processed wastewater will be recycled. During an emergency, when this is not possible, the wastewater would be released to a series of retention ponds located on the north end of the plant site. These ponds would provide sedimentation and natural purification prior to the release of the wastewater downstream.

All waste solids in the proposed system would normally be withdrawn from the sedimentation basins and applied in shallow layers in the solids drying ponds. Requirements for the probable solids disposal are indicated in Table 1-10. Natural freezing of waste solids would occur during the winter months. The characteristics of waste solids from alum coagulation undergo a marked change when subjected to complete freezing and thawing. They lose their gelatinous character and assume an appearance of dried coffee. Rapid dewatering and drying are promoted because these solids settle, thicken, and dry much more rapidly. Solids would be removed on an annual or semi-annual basis.

After a lagoon reached its maximum capacity, the water cover would be drained from the surface and valves on the underdrain system opened. Water would be drained to the lower retention ponds which would function to remove the remaining settleable solids and stabilize the wastewater prior to release. Front loaders or scrapers would then remove the concentrated solids, which would be transported to one of two possible disposal sites. One site is located in an abandoned limestone quarry in SE 1/4 of Section 2, Township 7 South, Range 69 West (Map 1-2). The second site would be located on DWB-owned property in NE 1/4 of Section 34, Township 6 South, Range 69 West (Map 1-2). In either case the sludge would be transported to the disposal site where it would be dumped and covered with soil. As each section is filled, the earth cover would be replaced and graded so the site would conform as nearly as possible to original contour. The site would then be seeded. The amount of dry sludge produced over the life of the project, 75 years, would be an estimated 101,288 cubic yards at 125 mgd and 640,575 cubic yards at 500 mgd. This would approximately level a 6-acre disposal pit at 125 mgd and a 38-acre pit at 500 mgd.

Access to the treatment plant would be controlled at the single-entry point provided. Two-way communication with visitors would be possible from the control building prior to their admittance. The operator would have visual contact from the office area with all vehicles that approach the parking complex.

TABLE 1-10

SLUDGE PRODUCTION FROM THE OPERATION OF THE PROPOSED TREATMENT PLANT
DURING BASE LOAD OPERATION

Condition	Quantity as Dry Solids (125 mgd) (1lb/day)	Quantity as Dry Solids (500 mgd) (1lb/day)	Quantity as 1% Solids (gal/day) (125 mgd)	Quantity as 1% Solids (gal/day) (500 mgd)	Quantity as Dry Solids (Cubic yd/day) (125 mgd)	Quantity as Dry Solids (Cubic yd/day) (500 mgd)
Annual Average Day	4,490	28,500	54,424	345,454	3.7	23.4
Average Day During Maximum Month	34,375	99,000	416,666	1,200,000	28	81.5
Average Day During Minimum Month	4,140	8,300	50,181	100,606	3.4	6.83

All control functions required to operate the plant, including filter backwash, would be controlled from a central control room within the plant. Using a direct digital, computer-based operation, one man would be able to monitor and control the treatment processes throughout the plant. This system allows for ultimate integration into the general DWB system.

In addition to the DWB proposal, the Aurora intertie conduit would provide an emergency source of raw water (up to 150 mgd) to the Foothills Treatment Plant from the existing Rampart Reservoir and vice versa. This would allow either water department (Aurora or Denver) to temporarily shut down its tunnel and conduit systems and perform periodic repairs and inspections. It would also provide emergency sources of water if any part of the tunnel, conduit, or intake systems should fail.

Conduit No. 27 and Second Parallel Conduit

Conduit No. 27 is proposed as a buried 108-inch non-corrosive steel or concrete pipeline with a design capacity of 350 mgd that would originate at the Foothills Treatment Plant and extend, in a northeasterly direction, 53,800 feet to the existing Highlands Reservoir and Pump Station (Maps 1-2 and 1-3). An additional 350 mgd capacity conduit would be required for max-hour transmission with treatment plant capacity at 500 mgd. Conduit No. 27 would tie into Conduit 96 and Highlands Reservoir and would extend about 33,000 feet on to Hillcrest Reservoir as a 90-inch pipeline (Maps 1-3 and 1-4). From the treatment plant, the pipeline would parallel Roxborough Park Road for about 5,900 feet and then turn northeast, paralleling the Aurora aqueduct (47,600), which is encased in concrete and crosses under Plum Creek just upstream of the highwater line of Chatfield Reservoir. Conduit No. 27 would pass under the Atchison, Topeka, and Santa Fe Railroad, the Denver and Rio Grande Western Railroad, and U.S. Highway 85. Periodic location markers and human access hatches would be located along the length of the conduit.

Between the proposed treatment facilities and the Highlands Reservoir and Pump Station, a 100-foot right-of-way adjacent to the Aurora aqueduct has been purchased by the DWB for installation of the conduit and its subsequent operation and maintenance.

The right-of-way for the conduit from Highlands to South Colorado Boulevard and Dry Creek Road would be 100 feet in width, parallel and adjacent to the existing Aurora pipeline right-of-way. From Colorado Boulevard and Dry Creek Road to Colorado Boulevard and Euclid Avenue, the conduit would be in the street right-of-way for South Colorado Boulevard. From South Colorado Boulevard and Euclid Avenue to South Holly Street and Princeton Avenue, the conduit would be in an 80-foot DWB right-of-way now used for 36-inch Conduit No. 85. From this point to Quincy Avenue and Happy Canyon Road, the conduit would be in street right-of-way, then on DWB property to Hillcrest Reservoir.

A trench, approximately 15 feet wide and 15 feet deep, would be excavated. Excavated material would be stacked temporarily alongside the trench. The remainder of the right-of-way would be used for temporary pipe storage, working area, and a graded access road. Major drainage crossings would be covered by concrete caps to prevent erosion and protect the conduit. The railroad crossing would require tunneling, whereas streets and highways would be trenched halfway across while traffic uses first the undisturbed and then the backfilled side.

After installation of the conduit, the excavated material would be replaced in the trench and the disturbed area would be reshaped and seeded to establish a suitable vegetative cover. The access road, paralleling Conduit No. 27, would be kept in repair for use during construction of the proposed project and seeded after completion of construction. However,

maintenance and inspection crews would continue to use it for operation access. About 115 acres would be disturbed, of which about 5 acres would be along the 5,900-foot segment adjacent to the Roxborough Park Road; 100 acres would be along the segments with no existing access roads, and about 10 acres would be in city streets.

The description of the second conduit parallel to Conduit No. 27 would be exactly the same. The second conduit would be laid 10 feet away and along side of Conduit No. 27 within the same right-of-way.

After construction treated water would be stored in the clear-water reservoir and metered into Conduit No. 27 on the plant site. Water would flow through Conduit No. 27 by gravity. The water would divide near Highlands Reservoir. About 30 mgd would flow into existing Conduit No. 96 (48-inch main), about 20 mgd would flow into Highlands Reservoir, and the balance of 75 mgd would flow on to Hillcrest Reservoir for storage and distribution when the treatment plant is operating at peak capacity.

Future distribution of the water from the second conduit is unknown.

Interrelationships with Other Projects and Proposals

The proposed Strontia Springs Diversion Dam and Reservoir and Foothills Treatment Plant would receive raw water from the DWB's South Platte and Roberts Tunnel Systems.

The following discussion addresses existing water developments that are directly or indirectly related to the proposed Foothills Project. Proposed projects that have the potential of providing raw water to the DWB are discussed in Chapter 8.

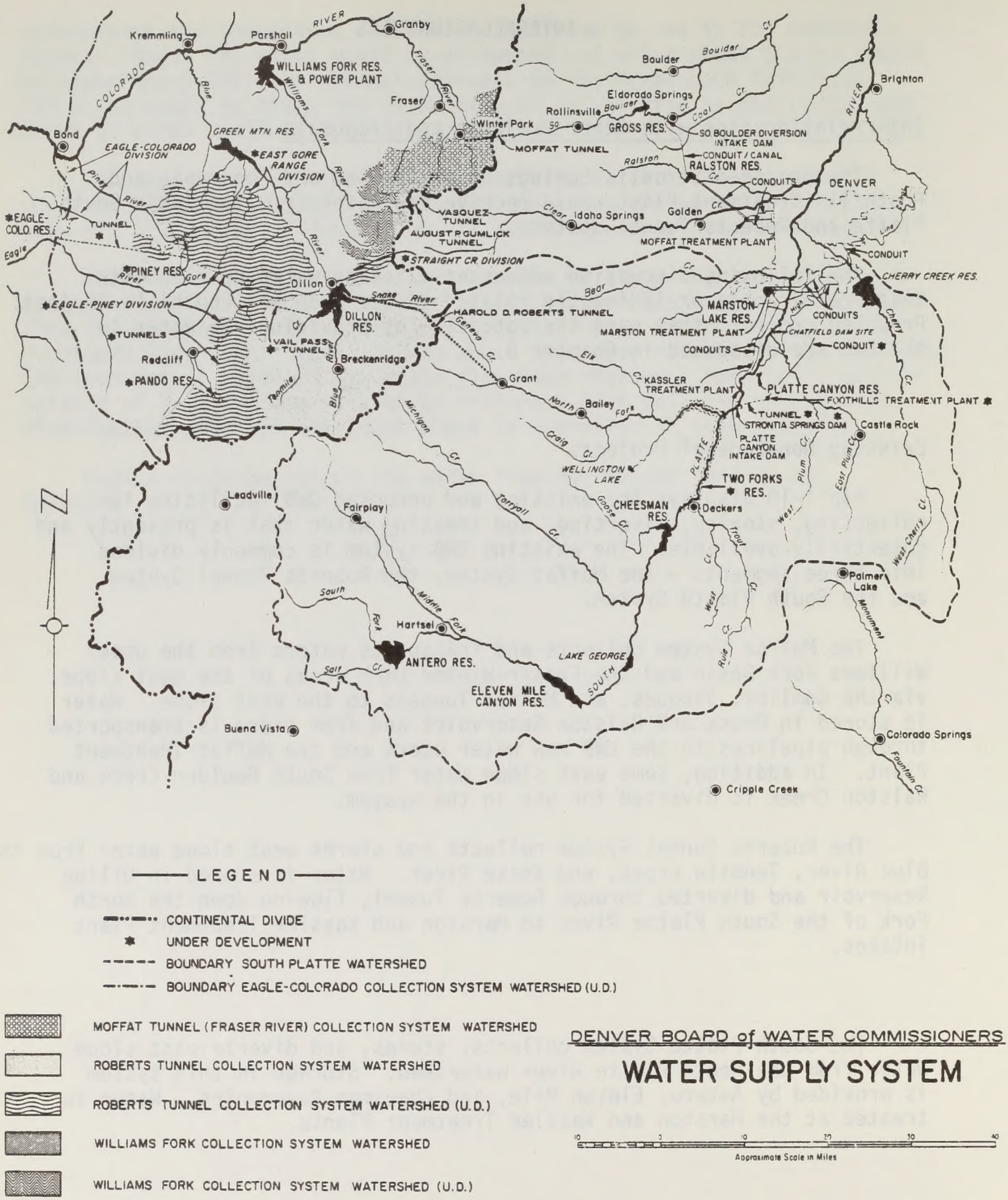
Existing Non-Federal Projects

Map 1-10 displays the existing and proposed DWB facilities for collecting, storing, diverting, and treating water that is presently and potentially available. The existing DWB system is commonly divided into three segments - the Moffat System, the Roberts Tunnel System, and the South Platte System.

The Moffat System collects and transports waters from the upper Williams Fork Basin and the Fraser-Winter Park areas of the west slope via the Gumlick, Vasques, and Moffat Tunnels to the east slope. Water is stored in Gross and Ralston Reservoirs and from there is transported through pipelines to the DWB raw water users and the Moffat Treatment Plant. In addition, some east slope water from South Boulder Creek and Ralston Creek is diverted for use in the system.

The Roberts Tunnel System collects and stores west slope water from the Blue River, Tenmile Creek, and Snake River. Water is stored in Dillon Reservoir and diverted through Roberts Tunnel, flowing down the North Fork of the South Platte River to Marston and Kassler Treatment Plant intakes.

The South Platte System collects, stores, and diverts east slope water from the South Platte River watershed. Storage in this system is provided by Antero, Eleven Mile, and Cheesman Reservoirs. Water is treated at the Marston and Kassler Treatment Plants.



MAP 1-10

Source: DWB, 1973

Existing Federal Projects

Green Mountain Reservoir, located downstream of Dillon Dam on the Blue River, is operated by the Bureau of Reclamation as part of the Colorado-Big Thompson Project. In accordance with the Blue River Decree, Green Mountain Reservoir, having storage rights senior to Dillon Reservoir, is entitled to be filled one time any year by runoff originating within the Blue River watershed before any of that year's runoff may be stored in Dillon Reservoir. Release of waters stored in Dillon Reservoir from previous years is not required.

There are three Corps of Engineers projects within the Denver metropolitan area that are or will be providing flood control protection and various recreation opportunities.

1. Cherry Creek Dam and Reservoir, located on Cherry Creek in the southeast metropolitan area has a total storage capacity of 96,000 acre-feet with 81,000 acre-feet reserved for flood control.

2. Mt. Carbon Dam; under construction and located on Bear Creek east of Morrison, will have a storage capacity of 52,000 acre-feet, primarily for flood control.

3. Chatfield Dam and Reservoir is located on the South Platte River immediately downstream of the confluence with Plum Creek. Total storage capacity at the top of the flood control pool (elevation 5,500 feet) is 235,000 acre-feet. The flood control objective of Chatfield Dam and Reservoir is to control South Platte River flows downstream of the dam to a maximum of 5,000 cfs.

Planned Developments and Proposals

In October 1974, the Bureau of Reclamation published a field draft feasibility report which presented the results of an investigation of the Upper South Platte Unit, Pick-Sloan Missouri Basin Program, Colorado.

The report presented for public and governmental evaluation engineering, economic, environmental, and social analyses of alternative water supply plans in the Upper South Platte River Basin. These alternative plans were multipurpose in scope and considered the full development potentials of the resource (hydroelectric power, municipal and industrial water, and enhancing fish and wildlife, outdoor recreation and environmental quality) to help meet the growing needs of the entire Denver metropolitan area and contiguous region. Although the report contains conclusions of the investigation, it does not recommend any administrative action.

Three alternative water storage facilities to provide water service for the entire Denver metropolitan area were evaluated in the investigation: West Plum Creek in the foothills, Ferndale on the North Fork of the South Platte River, and Two Forks on the South Platte River about two miles upstream from DWB's proposed Strontia Springs Dam. The Two Forks alternative required an afterbay for power and diversion functions. This dam, Turkshead, would also be required for Ferndale and West Plum Creek alternatives, to divert water to DWB's proposed Foothills Treatment Plant.

Turkshead Dam, to be located 1.9 miles downstream from the Two Forks Dam site, would not be constructed if Strontia Springs is built. However, the primary purpose of Strontia Springs is for diversion of existing water supplies to the proposed Foothills Treatment Plant, and it would serve this function independent of any of the Upper South Platte Unit storage alternatives. Strontia Springs Dam is designed with a spillway capable of passing the inflow-design flood without upstream storage. Therefore, the proposed Strontia Springs Dam is compatible with the major storage options studied in the Bureau of Reclamation's report and could serve the afterbay and/or diversion dam purposes outlined there if one of those options were favorably recommended by the Bureau of Reclamation and approved and funded by Congress.

The Two Forks Dam and Reservoir described in Concept A in Chapter 8 is considerably smaller than the Two Forks alternative discussed above, since the 1974 storage alternative would provide regulation of raw water supplies for the entire metropolitan area as well as providing for other multi-purpose uses (as described earlier). The Foothills Project Concept A requires regulation for only enough raw water to serve a 500 mgd plant.

The DWB owns two conditional decrees for storage rights in the Two Forks Reservoir alternative discussed above. These decrees are for 145,133 and 191,235 acre-feet of water annually; they have appropriation dates of January 18, 1905, and May 1, 1926, respectively. If Two Forks Reservoir were constructed, these rights would become decreed and would be exercised by the DWB.

In 1932, BLM allowed a right-of-way grant for the DWB to construct and operate a dam and reservoir on BLM and Pike National Forest lands. This grant was for a structure similar in location and size to the Bureau of Reclamation alternative mentioned above as Two Forks, except that it would be essentially a single purpose water development for municipal and industrial purposes. The DWB has continued to acquire lands and other rights from private landowners in the area of this right-of-way. However, they have delayed planning and predesign efforts pending a recommendation and decision regarding potential construction of one of the major storage alternatives in the Upper South Platte study area. Should the DWB decide to proceed with these plans as a non-Federal project, BLM would be required to comply with the National Environmental Policy Act.

<u>Interrelationships with Bureau of Land Management Multiple Use Planning System in the Study Area</u>

No element of BLM's planning system will be initiated in the study area until 1983. At that time, Unit Resource Analysis (BLM Manual 1605) would begin on the front range.

CHAPTER 2

DESCRIPTION OF THE PRESENT ENVIRONMENT

PRESENT ENVIRONMENT

The description of the environment is organized into categories which relate to all classes of land ownership. The aspects of the environment which are described in each category are most likely to be affected by the proposed Foothills Project. The degree of detail used in the description is related directly to the degree of anticipated impacts.

The area that would be affected by the Foothills Project is generally in metropolitan Denver. It includes a linear area extending from Highlands Reservoir in Littleton southwesterly to the proposed treatment plant site near Roxborough Park, the South Platte Canyon from Chatfield Reservoir to South Platte, and the North Fork of the South Platte River, Dillon Reservoir, the Blue River, and the South Platte River below Denver are affected to a much lesser degree.

SOCIO-ECONOMIC CONDITIONS

Human Populations

The socio-economic environment related to the Foothills Project centers around the Denver metropolitan area and consists of six counties: Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson. The Denver metropolitan area is the largest in the Rocky Mountain states. The median population in 1970 for the six Denver area counties was 173,965, ranging from 8,407 in Douglas County to 514,678 in Denver County. The total population of the six counties was 1,235,936 (U.S. Bureau of the Census 1973).

In 1975, the estimated median population for the six counties was 213,000, a median increase of 42,150 (27.9 percent). The range decreased because Denver lost population at the top of the range and Douglas at the low end gained. The estimated 1975 range was 15,700 in Douglas County to 489,000 in Denver County. Total population for the six counties in 1975 was estimated at 1,402,500 (U.S. Bureau of the Census

1976). Because of Denver's estimated decline in population, the six counties' estimated percent gain was slightly lower than the state's (13.3 percent compared to 14.7 percent).

The Denver Water Board (DWB) service area occupies a large portion of the six-county Denver area. The actual population of the service area in 1975 was 876,400 which was 62.5 percent of the estimated 1975 population (1,402,500) of the Denver area. Population growth in the six-county area was 13.3 percent during the period 1970-1975, whereas the DWB service area grew 14.1 percent, from 768,000 to 876,400 (DWB Annual Report 1975).

In summary, in 1970 and 1975 the counties in the Denver area, including Denver City and County, were for the most part urban, with population densities that would be expected in urban areas. The exception to this was Douglas County, which was still largely rural.

Employment and Manpower

The Denver-Boulder Labor Market Area (DBLMA) seasonally adjusted unemployment rate in March 1977 was 6.5 percent, down slightly from 6.8 percent in March 1976 (Table 2-1). The construction industry accounted for 25.9 percent of all the unemployed in the DBLMA, considerably under the 29.3 percent recorded in March 1976. The DBLMA's labor force grew from 704,200 to 725,600 between March 1976 and March 1977.

Income

Weekly earnings in the DBLMA during 1976 ranged from a low of $90.95 for hotel, tourist court and motel workers to a high of $308.67 for contract construction workers. The median for all workers was $217.09 per week, the equivalent of $11,288.68 if work was attainable for the full year. If contract construction workers worked 52 weeks in 1976 they earned $16,050.84; hotel, tourist court and motel workers under the same circumstances would have earned $4,729.40 (Table 2-2).

TABLE 2-1

CHARACTERISTICS OF THE DENVER-BOULDER LMA INSURED UNEMPLOYED 1/

	TOTAL			PERCENT DISTRIBUTION		
	MAR 1977	FEB 1977	MAR 1976	MAR 1977	FEB 1977	MAR 1976
INDUSTRY						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Mining	148	181	127	1.0	1.2	0.9
Construction	3,753	4,203	4,103	25.9	28.9	29.3
Manufacturing	2,673	2,538	2,849	18.5	17.4	20.3
Transportation & Public Utilities	649	635	671	4.5	4.4	4.8
Wholesale & Retail Trade	3,277	3,011	2,342	22.6	20.7	16.7
Finance	771	641	694	5.3	4.4	5.0
Services (& Farm)	2,397	2,506	2,297	16.5	17.2	16.4
Other	817	829	918	5.6	5.7	6.6
OCCUPATION						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Prof., Tech., & Mgr.	1,921	1,852	3,096	13.3	12.7	22.1
Clerical	1,260	1,321	1,984	8.7	9.1	14.2
Sales	482	466	738	3.3	3.2	5.3
Services	585	583	932	4.0	4.0	6.7
Processing	373	363	515	2.6	2.5	3.7
Machine Trade	373	330	850	2.6	2.3	6.1
Benchwork	469	401	515	3.2	2.8	3.7
Structural Work	1,542	1,755	3,692	10.6	12.1	26.4
Misc. (Farm)	7,480*	7,473*	1,679	51.6*	51.4*	12.0
AGE						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Under 25	2,673	2,519	2,738	18.5	17.3	19.6
25-34	5,385	5,608	5,497	37.2	38.6	39.3
35-44	2,635	2,513	2,357	18.2	17.3	16.8
45-54	2,108	2,202	1,977	14.6	15.1	14.1
55-64	1,465	1,451	1,320	10.1	10.0	9.4
65 & Over	219	251	112	1.5	1.7	0.8
WEEKS UNEMPLOYED						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
1-2	2,975	3,426	3,618	20.5	23.6	25.8
3-4	2,146	2,474	1,880	14.8	17.0	13.4
5-8	3,657	3,594	3,386	25.2	24.7	24.2
9-14	3,252	2,843	2,491	22.5	19.5	17.8
15-19	1,343	1,243	1,186	9.3	8.5	8.5
20 & Over	1,112	965	1,440	7.7	6.6	10.3
SEX						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Male	9,986	10,102	10,048	68.9	69.5	71.8
Female	4,498	4,442	3,953	31.1	30.5	28.2

1/ The characteristics of the insured unemployed are gathered by means of a Statewide 20 percent sample of claimants who filed a continued claim during the survey week of each month. These unemployed claimants filing for, or receiving, unemployment benefits under the Colorado Employment Security Act represent only one segment of the total estimated number of unemployed. Data is tabulated for Local Offices of the Division of Employment which service the Counties of Adams, Arapahoe, Boulder, Denver, Douglas, Clear Creek, Gilpin, and Jefferson.

Detail may not add to total due to rounding.

* Due to changes in the computer processing of claims data, an abnormal number of claimants could not be classified as to occupation during the indicated months. Other claimant characteristics are not affected.

TABLE 2-2

HOURS AND EARNINGS FOR SELECTED INDUSTRIES 1/

DENVER-BOULDER LMA 4/

	AVERAGE WEEKLY EARNINGS			AVERAGE WEEKLY HOURS			AVERAGE HOURLY EARNINGS		
	NOV 1976 2/	OCT 1976 3/	NOV 1975	NOV 1976 2/	OCT 1976 3/	NOV 1975	NOV 1976 2/	OCT 1976 3/	NOV 1975
CONTRACT CONSTRUCTION	$308.67	$312.98	$280.80	37.1	37.8	35.1	$8.32	$8.28	$8.00
MANUFACTURING	216.11	218.14	212.66	39.8	40.1	40.2	5.43	5.44	5.29
Durable Goods	216.14	215.87	211.58	40.4	40.5	40.3	5.35	5.33	5.25
Ordnance & Febricated Metals	239.97	237.44	216.37	42.1	42.1	39.7	5.70	5.64	5.45
Machinery, except Electrical	253.76	248.27	238.29	41.6	40.7	42.4	6.10	6.10	5.62
Nondurable Goods	216.06	220.97	213.07	39.0	39.6	39.9	5.54	5.58	5.34
Food & Kindred Products	218.04	229.49	230.60	37.4	38.7	41.4	5.83	5.93	5.57
Printing & Publishing	230.25	224.92	215.97	37.5	37.3	37.3	6.14	6.03	5.79
COMMUNICATION, ELECTRIC, GAS & SANITARY SERVICES	255.33	260.98	236.99	40.4	40.4	40.1	6.32	6.46	5.91
WHOLESALE TRADE	219.23	220.18	214.38	39.5	39.6	39.7	5.55	5.56	5.40
RETAIL TRADE, except Eating & Drinking Places	151.90	150.42	139.38	35.0	34.9	34.5	4.34	4.31	4.04
FINANCE & INSURANCE CARRIERS	168.84	168.86	163.12	-	-	-	-	-	-
HOTELS, TOURIST COURTS, & MOTELS	90.95	90.91	90.55	31.8	33.3	31.7	2.86	2.73	2.86
LAUNDRIES & DRY CLEANING PLANTS	101.87	103.36	107.54	34.3	34.8	37.6	2.97	2.97	2.86

1/ Averages, prepared in cooperation with the Bureau of Labor Statistics, based upon data for full and part-time production, working supervisory, and related employees who worked during the pay period including the 12th of the month. Average earnings are computed on a "gross" basis and may reflect change in basic hourly and incentive wage rates. Average hourly earnings are not wage rates but averages of gross earnings of all employees below administrative level.

2/ Preliminary estimates for November 1976.

3/ Revised.

4/ Includes Adams, Arapahoe, Boulder, Denver, Douglas, Clear Creek, Gilpin, and Jefferson counties.

Source: Larson 1976

Utilities

Municipal and Industrial Water Systems

In 1977, the DWB system has the capability to deliver 520 million gallons per day (mgd) of treated water to its customers within the service area. There are three treatment facilities having the following capacities:

Moffat Plant	210 mgd
Kassler Plant	50 mgd
Marston Plant	260 mgd
Total	520 mgd

Maximum single day use during 1964 - 1973 averaged 480 mgd. However, in 1973 and again in 1975 the maximum-day use exceeded the available treatment capacity of 460 mgd and of 490 mgd, respectively. On that occasion in 1973 the max-day demand was 506 mgd and in 1975 it was 500 mgd. Treated water stored within the DWB transmission system was used to satisfy the additional demand.

The treated water storage capacity within the DWB transmission system as of 1975 was 287.8 million gallons. Consumption rates of treated water in the DWB treated water service area range from a monthly low average of 117 gdc (gallons per capita per day) in January to a high of 370 gdc in July. In 1973 per capita use of treated water reached a high of 608 gallons on a single day.

The average annual treated water use rate for the period 1971-1975 was 181 gdc, which reflected all uses of treated water within the DWB treated water service area - residential, commercial, industrial, construction, fire protection, governmental, and transmission system losses. Using data presented in the DWB 1973 Annual Report, 51 percent of the treated water utilized went to commercial, industrial, construction, fire protection, and governmental users and for system losses. The remaining 49 percent was used in residences.

Table 2-3 presents the annual quantity and percentage breakdown of the residential use of water by a typical family of four. About 40 percent of the treated water used by the typical family was for yard irrigation.

The pattern of treated water usage varies throughout the year. Table 2-4 displays the quantity and percentage of treated water used by month.

TABLE 2-3

QUANTITY AND PERCENTAGE OF RESIDENTIAL WATER USED FOR DIFFERENT PURPOSES BY A FAMILY OF FOUR

Use	Annual Quantity of Water Used (in 1000 Gallons)	Percentage
Irrigation	76	39.8
Toilet flushing	51	26.7
Bathing	34	17.8
Life functions	14	7.3
Cleaning and laundry	11	5.8
Miscellaneous	5	2.6
Total	191	100.0

Source: DWB 1974.

TABLE 2-4

QUANTITY OF TREATED WATER AND PERCENTAGE OF AVERAGE ANNUAL WATER SUPPLY USED BY MONTH

Month	Quantity of Treated Water Used (in Acre-feet) 1/	Percentage
January	8,000	4.7
February	7,300	4.3
March	9,000	5.3
April	11,600	6.8
May	17,700	10.4
June	23,000	12.9
July	25,400	14.9
August	24,900	14.6
September	16,400	9.6
October	11,400	6.7
November	8,500	5.0
December	8,200	4.8
Total	170,400	100.0

Source: DWB 1973

1/ Assuming an average annual consumption of 170,400 acre-feet (average annual water supply consumed for the period 1964-1973).

Wastewater Treatment Facilities

There are presently 15 wastewater treatment facilities discharging to the streams in the Denver Metropolitan Area. The major facilities and their 1975 flows are shown by Table 2-5. In addition, Table 2-5 shows the existing capacity of the facilities and summarizes the facility briefly.

TABLE 2-5

MAJOR WASTEWATER FACILITIES
AND THEIR 1975 FLOWS

Facility	1975 Flows (mgd)	Existing Capacity (mgd)	Comments
Englewood/Littleton	14.5	20.0	New facility
South Lakewood	1.9	2.4	201 study in progress
MDSDD #1	132.0	170.0	70 mgd just completed
Sand Creek (Aurora)	1.1	1.0	201 study in progress
South Adams County	2.0	2.4	Adding 1.8 mgd
Broomfield	1.6	3.6	2.0 mgd just completed
Westminster	0.6	1.0	210 study in progress/ adding 1.0 mgd for the short term
Glendale	0.7	1.0	Adding 1.0 mgd
Morrison	0.05	0.07	-
Arvada	1.0	1.0	Excess flows to MDSDD #1

As may be seen, MDSDD #1 provides nearly 85 percent of the wastewater treatment capacity. This facility is actually a joint facility with the Denver Northside (DNS) primary treatment facility which has a treatment capacity of 106 mgd. The DNS facility discharges to the MDSDD #1 facility primary effluent which is treated to a secondary level and discharged to the South Platte River.

All facilities in the Denver area are presently treating to a secondary treatment level as required in their NPDES discharge permits. Eight 201 facility plans are ongoing to evaluate both increasing capacity and treatment levels in the area. These studies are being closely coordinated with the 208 Areawide Water Quality Study being conducted by the Denver Regional Council of Governments (DRCOG). This coordination, required by

the State and the U.S. Environmental Protection Agency, has developed a process in which treatment capacity is available in a timely fashion and is consistent with regional and local planning.

Generally, over the past two years significant improvement in the treatment of municipal discharges has occurred. Bascially, this has occurred through the addition of nearly 100 mgd in new treatment capacity in the metropolitan area. The 70 mgd expansion at the MDSDD #1 will give that facility an ability of discharging effluent 33 percent better than federal regulations, which limit biological oxygen demand (BOD) to 30 ppm.

In addition, the major discharges of pollution from raw sewage because of inadequate interceptor capacity are being continuously eliminated. The Platte River II interceptor, which is nearing completion, will eliminate all of these raw sewage discharge points along the South Platte River. Only minor raw sewage discharge points, which discharge very infrequently under unique meteorological conditions, will continue in existence. Even these relatively minor discharge points are being eliminated in the near future by facility improvements.

Law Enforcement

The Denver area ratio of police personnel to population was below the national average for metropolitan areas with a population of over 500,000 (DRCOG 1974a). In 1974, within the six counties in the Denver area there were 3,466 uniformed and civilian police personnel assigned as follows: to the City and County of Denver, 1,649 (or 47.6 percent); to the sheriff's departments in the other five counties in the Denver area, 506 (or 14.6 percent); to the Colorado State Patrol, 223 (or 6.4 percent); and to the police departments of various municipalities in the other five counties, 1,087 (or 30.4 percent).

Fire Protection

DRCOG gathered data on fire departments in the Denver area. It found that there were 22 fire departments with 1,919 personnel, including uniformed civilian and volunteer, which had 209 pieces of equipment in 87 stations, including one station at Stapleton Airport.

A most meaningful datum from the survey was the Town-Index fire-hazard rating of the various political subdivisions in the area. The Insurance Services Office use a ten-point scale (Table 2-6) to rate municipal fire protection. No city in the United States presently has a rating of one. Denver is one of three cities in the country that has a rating of two, meaning that people residing within the Denver County boundaries have the best available fire protection in the United States today. But, the median rating for the 22 fire departments in the area was 7, which means that, except for Denver and Aurora, fire protection in the area is below the quality which the fire Insurance Services Office of Colorado-Wyoming consider desirable.

Community Attitudes

A BLM staff summary of media reports on community attitudes toward the project shows that attitudes are sharply divided. At one pole are the environmentalists, the restricted growth factions, and those who do not want additional transmountain diversion of westslope water. At the other pole are those who wish Denver to continue uninhibited growth. In addition, they wish to see no change in life styles, especially those related to horticulture and recreation. This group believes cheap, plentiful water is necessary for this.

Opinions concerning the project are not necessarily related to the holder's geographic location. Public opinion in the DWB service area is mixed; however, west of the Continental divide, opinion generally opposes projects that would divert westslope water to the eastslope. The intensity of positive or negative opinions toward the project do not emanate from large numbers of people. On both sides, the project is being discussed by informed minorities. Within Denver County, a bond issue for $160 million in capital improvements, of which the Foothills Treatment plant was one item, was voted on in 1972 and again in 1973. The first vote was held in July 1972 with 51,000 voters taking part. Of these, 27,300 (54.0 percent) voted against the capital improvements. Only 17.5 percent of the 291,600 registered voters took part in the election. After an intense campaign in which the Sensible Water Use Coalition (SWUC) spent $18,000 opposing the improvements and the Water for Denver Committee (WDC) spent $96,000 supporting them, another election was held in November 1973. With 24 percent of the electorate turning out, the proportions were reversed, 56 percent, or 39,270, voting yes on the improvements and 44 percent, or 30,800, voting no. A large majority of the county electorate (76 percent) did not vote, suggesting that the project was the concern of informed minorities.

A public opinion survey conducted using DWB funds indicated, in part, that the public may be receptive to municipal and industrial water conservation programs (Carley 1973). In 1971 Carley asked a sample of 440 Denver household residents questions related to waste, reuse, conservation, and new sources of water. Carley found that:

TABLE 2-6

FIRE-HAZARD RATINGS FOR POLITICAL ENTITIES

Rating 1/	Percent of Total Fire Protection Index 2/
1	100
2	88.9
3	77.8
4	66.7
5	55.6
6	44.5
7	33.4
8	22.3
9	11.2
10	0

Source: Town-Index; Colorado-Wyoming September 1975; Insurance Services Office of Colorado-Wyoming, Denver, Colorado.

1/ A rating of "1" is perfect fire protection. A rating of "10" is no fire protection.

2/ The fire systems were rated according to four variables: (a) 39% for the fire department itself; (b) 39% for the water supply; (c) 13% for the fire safety control, regulations, ordinances, enforcements, etc.; (d) 9% for the communication system.

"The results . . . indicates that the water shortage problem is of less concern than at least six(sic) (the actual number is 5) other environmental problems, which lends credence to the oft-cited hypothesis that water is a concern of low-visibility."

Sixty-five percent of the respondents ranked air pollution as the most important problem; 15 percent, population growth; 5 percent, water pollution; 4 percent, noise problems; and 4 percent, urban growth. Three percent listed water shortage as the most important problem.

When asked, "If Denver were to forsee a water shortage, can you think of any steps that the city might take to meet the problem?" 25 percent could not suggest a single supply step. Of those who could, 46 percent said to restrict water use; 17 percent said develop more supplies; 11 percent, recycle or re-use; 10 percent, install more meters; 5 percent, restrict growth; and 4 percent, educate the public.

When presented with a list of water supply alternatives and asked their attitudes toward them, the response was: develop more mountain supplies, 88 percent; re-use for irrigation (parks and golf courses), 87 percent; restrict summer watering, 82 percent; restrict city growth, 63 percent; limit lawn size, 56 percent; metering, 49 percent; and re-use for drinking, 38 percent. A majority of the respondents had positive attitudes toward five out of the seven alternatives presented.

When asked for their preferences among future water supply alternatives, over 96 percent were for five alternatives: restrict summer watering, 98 percent; limit lawn size, 97 percent; restrict city growth, 97 percent; develop more mountain supplies, 96 percent; and re-use for drinking, 96 percent.

It appears from the foregoing that when presented with a list of future water supply alternatives, the overwhelming majority of the 440 respondents preferred all of them.

In summary, Carley's 1971 study confirmed the notion that the water supply problem is one of low visibility, but when the public is presented with alternatives, it prefers to initiate all of them, whether it be water restriction, limiting lawn size, developing more mountain supplies, restricting city growth, or re-use for drinking.

Life Styles

Figures obtained from the 1970 census indicate that approximately 10.0 percent of the population in the six county Denver area had annual incomes below the poverty level and about 1.0 percent had annual incomes of $50,000 or more (U.S. Bureau of the Census 1973).

More recent poverty-affluency figures have not been published by the Census Bureau, but a rough estimate of the poverty level can be calculated from Colorado Department of Social Services data (personal communication, Division of Income Maintenance, Colorado State Department of Social Services 1977). Affluency level can be estimated from the Bureau's most recent per capita income estimates.

Data from the Colorado Department of Social Services show that the percent of population receiving public assistance during 1975-76 fiscal year was: Adams County, 9.8 percent; Arapahoe County, 3.4 percent; Boulder County, 5.3 percent; Denver County, 17.0 percent; Douglas County, 1.8 percent; and Jefferson County, 3.4 percent. The average for the six counties was 6.8 percent.

The population receiving public assistance does not constitute the entire population designated at the poverty level or less. There are two other groups included in the category: those not receiving public assistance who receive food stamps and, a perhaps smaller group, the poor who are eligible for food stamps and/or public assistance but who do not apply for either. The Department of Health, Education and Welfare has defined the 1976 poverty level as being an annual income of $5,500 or less for a non-farm family of four.

Colorado Department of Social Services statistics (personal communication, Branch of Food Stamps, Colorado State Department of Social Services 1977) show that the number of non-public assistance persons receiving food stamps in the six-county Denver area during February 1977 was 42,684, or approximately 3.0 percent of the estimated total population.

Presently available statistics do not show the number and percent of persons eligible for public assistance and/or food stamps who do not apply.

Combining the percent of population receiving public assistance and those not on public assistance receiving food stamps, it can be assumed that a minimum of 9.8 percent of the population in the six-county area is at the poverty level or below. This figure undoubtedly would be higher if data on those eligible for public assistance and food stamps who do not apply was known.

The Bureau of the Census has not released affluency statistics by county more recently than 1970. However, the Bureau has released estimated average per capita income figures for 1974 (Bureau of Census 1977). These show that the average per capita income in Adams County was $4,531; in Arapahoe County, $5,720; in Boulder County, $5,060; in Denver County, $5,585; in Douglas County, $5,116; and in Jefferson County, $5,625. This constitutes an average per capita income in the Denver area of $5,273. Based on the latter figure, the average income for a family of four would be $21,092. The average per capita income for the State in 1974 was $4,884, which projects to $19,536 for a family of four. Thus, the Denver area population is somewhat (8.0 percent) more affluent than the rest of the State in terms of money income.

Although Denver is in a semiarid region, residents of the area maintain extensive landscaped areas comprised of lawns, trees, shrubbery, and domestic plants by irrigating their yards, freeway embankments, and green belts with treated water. Area residents place a high value on these irrigated areas. This conclusion was reached by observing how much time and material resources were devoted to cultivating horticulture by Denver area residents. The key variables in this analysis were "free time" and "disposable income", with free time being more important as disposable income increases. Working people find it difficult to increase free time. It was assumed that the average resident has 30 hours of daylight free time in an average summer week (two hours each work day and ten hours each on Saturday and Sunday (5 x 2 = 10 + 10 + 10 = 30). If one hour per work day and two hours each on Saturday and Sunday is devoted to horticulture, (not counting time and money devoted to shopping for horticultural reasons), 30 percent of her/his time was used for residential horticulture. If one of the household partners did not work outside the home, the amount of daylight time devoted to horticulture was probably greater, and since in this case it was probably done during normal work day hours it was not included in the free time category.

After consultation with Wieder (1977), it was estimated conservatively that the average horticultural investment per dwelling unit in the six-county Denver area was $2000. This amount takes into account smaller plots in Denver county and multiple dwellings throughout the six-county area, as well as parks, golf courses, and highway medians. The average annual income for a family of four in 1974 was $21,091.32 in the six-county area (Bureau of Censes 1977). A $2000 investment in horticulture per dwelling unit is equal to 9.5 percent of this average annual income.

WATER RESOURCES

The proposed Foothills Project would be located in the South Platte River watershed southwest of Denver. Raw water would be diverted from the South Platte River at the proposed Strontia Springs Diversion Dam. This water derives from two sources - the South Platte River drainage east of the Continental Divide and in the Blue River drainage west of the Continental Divide. Map 1-10 depicts the existing sources of DWB raw water.

Present Raw Water Supply Systems

Present raw water supply is derived from the following sources.

Moffat System

The Moffat System collects and transports water from the upper Williams Fork Basin and the Fraser-Winter Park areas of the west slope via the Gumlick, Vasquez, and Moffat Tunnels to the east slope. In addition, some east slope water from South Boulder Creek and Ralston Creek is diverted for use in the system. It is stored in Gross and Ralston Reservoirs and from there is transported through pipelines to the DWB raw water users and the Moffat Treatment Plant.

The Moffat Treatment Plant has a capacity to treat 210 mgd. The collection and storage facilities of the Moffat System provide raw water to DWB raw water contractors and the Moffat Treatment Plant. The potential exists to expand the Williams Fork collection system and enlarge the storage capacity of Gross Reservoir.

The Moffat System collects, stores, and diverts waters which originate in the west slope watershed of the Williams Fork and Fraser Rivers and the east slope watersheds of South Boulder and Ralston Creeks. Such waters may be stored in Gross Reservoir (capacity 43,065 acre-feet) and Ralston Reservoir (capacity 11,272 acre-feet) before delivery to the raw water users or the Moffat Treatment Plant. Table 2-7 summarizes data obtained from DWB annual reports.

Average annual flow of the Williams Fork River near Leal, Colorado (a named USGS gaging station), downstream of the confluence of the South Fork of the Williams Fork and Williams Fork, was 69,000 acre-feet during the period 1964-73 after DWB Williams Fork diversions. The capacity of Williams Fork Reservoir is nearly 97,000 acre-feet. During the period 1969-1973, it supplied about 43,000 acre-feet on an average annual basis for exchange and replacement.

TABLE 2-7

MOFFAT SYSTEM WATER SOURCES AND USE
(ACRE-FEET)

	Williams Fork River	Fraser River	So. Boulder & Ralston Creeks	Raw Water Deliveries, Operating Losses, etc. 1/	Moffat Treatment Plant
1964-73 (Average)	4,900	47,900	11,500	11,800	52,500
1974	4,400	64,200	7,800	9,100	67,300
1975	5,800	55,600 2/	14,100	17,000	58,500

1/ The sum of Williams Fork River, Fraser River, South Boulder and Ralston Creeks less Moffat Treatment Plant represents raw water deliveries, operating losses, and storage changes.

2/ Includes Cabin-Meadow Creek System placed in service May 12, 1975.

Average annual flows of the Fraser River and several of its tributaries at locations downstream of the DWB diversion points for the ten-year period are:

Fraser River near Winter Park	13,200 acre-feet
Vasquez Creek near Winter Park	9,400
St. Louis Creek near Fraser	14,800
Ranch Creek near Fraser	7,900
Total	45,300 acre-feet

These are the flows remaining after DWB diversions. The average annual supply diverted from the west slope during 1964-73 via the Moffat Tunnel into the South Boulder Creek watershed was 52,800 acre-feet.

Downstream of the DWB South Boulder Diversion Intake Dam the average annual flow of South Boulder Creek near Eldorado Springs, Colorado was 46,100 acre-feet from 1964 to 1973 after the storage, regulation and diversion of the west slope and native South Boulder Creek waters by the DWB.

None of the raw waters available from the DWB Moffat System can be provided directly for treatment at the proposed Foothills Plant.

Roberts Tunnel System

The Roberts Tunnel System collects and stores west slope waters from the Blue River, Tenmile Creek, and Snake River, which are stored in Dillon Reservoir and diverted through the Roberts Tunnel, flowing down the North Fork of the South Platte River and then down the South Platte River to Marston and Kassler Treatment Plant intakes. Roberts Tunnel imports from the west slope began in 1964. With the introduction of Dillon Reservoir water into the channel of the North Fork, channel stabilization work was conducted by the DWB, principally along a 12.8-mile reach from the outlet portal of the Roberts Tunnel to a location about one mile downstream of Bailey, Colorado. Future raw water supplies that potentially could be added to the present Roberts Tunnel supplies include additional Blue River watershed diversions and Eagle River, Gore Creek and Colorado River diversions west of Vail Pass.

South Platte System

The South Platte System collects, stores, and diverts east slope water from the South Platte River watershed. Storage in this system is provided by Antero, Eleven Mile, and Cheesman Rerservoirs. Water is treated at the Marston and Kassler Treatment Plants. The Kassler treatment Plant has a capacity of 50 mgd. The Marston Treatment Plant has a capacity of 260 mgd; however, the conduit from the Platte Canyon Intake has a capacity of only 210 mgd. Additional raw water supplies from the South Platte River may be derived from additional storage on the South Platte River, exchange of sewage effluent derived from transmountain water with downstream water users and acquisition of water rights.

Downstream, within the Denver metropolitan area along the South Platte River, are eleven diversions, (Table 28). The DWB and the City of Englewood own the dominant portion of the water rights associated with these facilities.

The cities of Aurora and Colorado Springs jointly own the Homestake Project. Homestake Project water originates west of the Continental Divide in the Eagle River watershed. The water is stored in Homestake and Turquoise Lakes in the upper Arkansas River watershed and released to the Arkansas River near its confluence with Clear Creek. A conduit

TABLE 2-8

SOUTH PLATTE RIVER DIVERSIONS BELOW THE PROPOSED STRONTIA SPRINGS DAM SITE

Diversion Name	Ownership	Water Use 1/
Highline Canal	DWB	Municipal, industrial, irrigation
Flume to Kassler filters	DWB	Municipal, industrial
Last Chance	DWB (partial)	Municipal, industrial irrigation
City Ditch (out of Chatfield Dam and Reservoir) 2/	DWB City of Englewood	Irrigation City Park Use
McClelland Reservoir pump station	City of Englewood	Municipal, industrial
Brown Ditch	City of Englewood	Municipal, industrial, irrigation
	DWB	Future municipal and industrial
Petersburg Ditch	City of Englewood	Municipal, industrial
Public Service Company	DWB 3/	Arapahoe power plant
Epperson Ditch	City of Englewood DWB	None Golf course irrigation
Farmers & Gardeners	DWB 3/	Cherokee power plant

1/ User by each entity under "Ownership" column.

2/ Chatfield Dam and Reservoir does not store the water for the water owners. Provisions are designed into the facility to accommodate continual flow-through into the river system.

3/ The DWB owns the water and sells it to Public Service Company for power plant operations.

carries the water eastward to a point where the Aurora share of the water is conveyed to Eleven Mile Canyon Reservoir and the South Platte River. The remaining portion continues on to Colorado Springs. The City of Aurora water flows down the South Platte River to the existing Aurora intake, where the water is diverted to Ramparts Reservoir. The City of Aurora can divert up to 140 mgd (216 cfs) with its intake. The existing intake would be inundated by the proposed Strontia Springs Diversion Dam and Reservoir. A new intake structure for the City of Aurora is included in the plan described in the discussion of project components.

The DWB also diverts raw water from Bear Creek at the Bear Creek Diversion Dam near Morrison, Colorado. The water is conveyed to Marston Lake by the Harriman Canal. The DWB also shares ownership of Soda Lakes (DWB capacity - 660 acre-feet). Water obtained from Soda Lakes is also conveyed to Marston Lake by the Harriman Canal.

Clear Creek flows into the South Platte River north of the City of Denver, and services primarily downstream water rights outside of the metropolitan area. The Public Service Company receives part of its water from Clear Creek. The capacity of Williams Fork Reservoir is nearly 97,000 acre-feet. During the period 1969-1973, it supplied about 43,000 acre-feet on an average annual basis for exchange and replacement.

Developed from simulated operation of the DWB system, the average annual raw water supply for the 1947-1965 period was as follows (Table 2-9):

TABLE 2-9

AVERAGE ANNUAL WATER SUPPLY

Moffat System	92,000 acre-feet	29%
Roberts Tunnel System	124,000 acre-feet	40%
South Platte System	96,300 acre-feet 1/	31%
Totals	312,300 acre-feet 2/	100%

1/ Includes 14,300 acre-feet from Bear Creek and South Platte River ditches.

2/ Does not include operating losses.

From Table 2-10 it can be seen that the availability and location of the supply in the respective collection and storage systems varies.

TABLE 2-10

RAW WATER USE BY DWB AND ITS RAW WATER CONTRACTORS

System	1964-1973 Average	1974	1975
Moffat System	64,300 acre-feet (31%)	76,400 acre-feet (29%)	75,500 acre-feet (31%)
Roberts Tunnel System	29,600 acre-feet (15%)	42,710 acre-feet (17%)	46,400 acre-feet (19%)
South Platte System	111,400 acre-feet (54%)	140,200 acre-feet (54%)	122,800 acre-feet (50%)
Totals	205,300 acre-feet (100%)	259,300 acre-feet (100%)	244,700 acre-feet (100%)

Source: DWB Annual Reports, which include operating losses.

Factors in this variation are the availability and location of supply in the respective collection and storage systems, the annual demand for treated and raw water, and operational constraints imposed by maintenance or construction.

Water Rights

Under the laws of the State of Colorado, the DWB has obtained water rights which enable it to divert, store, and redivert raw water from east slope and west slope watersheds for ultimate consumption within the DWB service area. The operation of the DWB raw water system under such rights involves the coordinated operation of numerous collection, storage, conveyance, and diversion facilities to supply raw water to intakes of existing treatment plants - Kassler (50 mgd), Marston (260), Moffat (210 mgd) - and to raw water users. Use of different sources of water varies with hydrologic and climatic conditions, available reservoir storage, and demand for raw and treated water.

Flows and Reservoir Levels

A summary description of the watersheds from which the DWB obtains its raw water supplies follows. The discussion will address two of the three principal segments of the DWB system - the Roberts Tunnel System and the South Platte System. Although the third segment, the Moffat System, is coordinated with the others so that they all operate as one integrated whole, it is omitted from this discussion because it is not impacted by the proposal.

Raw water provided the DWB service area from the coordinated operation of the DWB system during the period 1964-1973 averaged 205,300 acre-feet per year. In 1974 and 1975 the total raw water provided was 259,300 and 244,700 acre-feet, respectively. Raw water that was treated by the DWB averaged 170,400 acre-feet annually during the ten-year period; it was 221,300 and 208,000 acre-feet in 1974 and 1975, respectively. The balance was provided to raw water users and absorbed as operating losses (DWB annual reports).

Roberts Tunnel System

The Roberts Tunnel System consists of Dillon Dam and Reservoir (capacity 254,036 acre-feet at 9,017 feet elevation) and the Harold D. Roberts Tunnel (maximum capacity 1,000 cubic feet per second (cfs)). Water from the Blue River was first diverted through the Roberts Tunnel in October 1963.

Runoff of the Blue River has been stored in Dillon Reservoir primarily during the months of May and June, when spring runoff is at its peak. Monthly diversions of water through the Roberts Tunnel to the North Fork of the South Platte River have generally been largest during July and August, coinciding with the period of greatest demand for water within the DWB service area.

TABLE 2-11

HISTORICAL MONTHLY AVERAGE DISCHARGE FROM THE ROBERTS TUNNEL, THE NORTH FORK OF THE SOUTH PLATTE RIVER AND THE SOUTH PLATTE FOR THE PERIOD 1964-1973 (in cfs)

Month	Roberts Tunnel Diversions	North Fork South Platte at Grant 1/	North Fork South Platte at South Platte 1/	South Platte River below South Platte 1/	South Platte River at Waterton
(1)	(2)	(3)	(4)	(5)	(6)
January	22	39	67	134	27
February	17	32	58	123	19
March	20	38	69	149	18
April	37	63	127	332	145
May	26	148	375	900	643
June	14	255	490	910	550
June	74	230	362	762	403
August	141	226	348	664	325
September	66	113	182	377	134
October	27	65	123	238	86
November	19	48	93	184	65
December	24	46	73	143	31
Average Annual	41	109	198	412	205
Acre-feet	29,600	79,000	143,500	298,000	148,400

1/ Includes historical Roberts Tunnel diversions.

Inflow to Dillon Reservoir for the period 1964-73 averaged 187,500 acre-feet annually. The average annual release from Roberts Tunnel for 1964-73 was 29,600 acre-feed. Table 2-11 presents the historical average monthly discharge of the Roberts Tunnel. Instantaneous (short-duration) flows from the Roberts Tunnel have varied from zero discharge on many occasions to 433 cfs during the period August 11 through 20, 1976. Releases made during the period August 18 through 28, 1974, which were relatively steady at 343 cfs, are more typical. The maximum annual diversion of water from Dillon Reservoir through the Roberts Tunnel was 50,400 acre-feet in 1967.

The content of Dillon Reservoir since the initial filling in 1965 has exceeded 200,000 acre-feet every year through 1973 (Table 2-12). It has been full (254,000 acre-feet) 20 percent of the time. The maximum drawdown of record was 17.7 feet below full storage, in April 1967. The average maximum annual drawdown of the reservoir during the period 1964-73 was about ten feet.

Dillon Reservoir at full capacity (9,017 feet elevation) has a water surface area of 3,233 acres. During the eight-year period 1966-73, the surface area reduction each year averaged 394 acres (Table 2-12).

Stipulations for the operation of Dillon Reservoir require release of natural inflow or 50 cfs, whichever is less, to maintain a live stream in the Blue River.

In addition, these stipulations affect the release of Blue River water to Green Mountain Reservoir. If, in a given year, Green Mountain Reservoir does not fill from runoff originating downstream of Dillon Dam and from spills from Dillon Reservoir, the DWB must release the amount of water necessary to fill Green Mountain Reservoir from Dillon Reservoir. Such a release need not exceed the amount necessary to fill Green Mountain Reservoir, and it need not include amounts stored in previous years that might now be necessary to fill Green Mountain Reservoir. Dillon Reservoir was filling during 1964 and 1965. After it began normal operation, average annual flows in the Blue River downstream of Dillon Dam during the 1964-73 period were 143,500 acre-feet.

Prior water rights downstream on the Colorado River are recognized by the DWB in its operation of the Roberts Tunnel and Moffat Systems collection and storage facilities. The DWB either bypasses inflow to the Colorado River or provides exchange and replacement water to the Colorado River from DWB's Williams Fork Reservoir to compensate for retaining water elsewhere.

The Colorado River has discharged at the Colorado-Utah State line an average of 4,241,000 acre-feet per year during the period 1964-73. Approximately 51 percent of this flow occurred during the months of May, June, and July on the average. During May and June of 1973, when most of the storing of water in upstream reservoirs was occurring, the Colorado River discharged about 2,371,000 acre-feet, or about 44 percent of the total 1973 flow.

TABLE 2-12

HISTORICAL ANNUAL MAXIMUM DRAWDOWN OF DILLON RESERVOIR AFTER INITIAL FILLING IN 1965

Year	Minimum Content During Year (acre-feet)	Month of Minimum Content	Number of Feet below Full Elevation (9,017)	Surface Acres Reduced
1966	221,600	December	10.6	385
1967	202,200	April	17.7	593
1968	222,000	May	10.5	588
1969	224,600	April	9.6	353
1970	238,600	March	4.9	195
1971	236,100	October December	5.7	228
1972	220,100	December	11.2	404
1973	219,200	March	11.5	413
Mean	223,050		10.2	393.6

Source: USGS 1964-1973.

South Platte System

The South Platte River originates in the Rocky Mountains northwest of Fairplay, Colorado. The South Platte River upstream from the Denver metropolitan area is a scenic mountain stream with frequent pools, riffles and fast shallow reaches. After leaving the mountains southwest of Denver, it meanders across the plains of northeastern Colorado and flows into the State of Nebraska near Julesburg, Colorado, and subsequently joins the North Platte River near North Platte, Nebraska. The drainage area of the South Platte River at various locations is shown in Table 2-13, with the average annual flow for the period 1964-73.

TABLE 2-13

SOUTH PLATTE RIVER DRAINAGE AREA AND AVERAGE ANNUAL RUNOFF, 1964-73 1/

Location	Drainage Area (sq. miles)	Average Annual Runoff (acre-feet)
SPR 3/ below Cheesman Dam	1,752	128,200
NFSPR 4/ at Grant	127	79,000 1/
NFSPR at S. Platte	479	143,500 1/
SPR at South Platte	2,579	298,000 1/
SPR at Waterton	2,621	148,400
SPR below Denver	4,400 (approx.)	469,000 2/

1/ Includes historical Roberts Tunnel imports from Dillon Reservoir and Homestake Project water.
2/ Includes Clear Creek and sewage return flows. Does not reflect depletions by the Burlington pump and canal.
3/ SPR - South Platte River.
4/ NFSPR - North Fork of the South Platte River.

DWB facilities on the South Platte River upstream of Waterton include Antero Reservoir (15,878 acre-feet), Eleven Mile Reservoir (97,779 acre-feet), Cheesman Reservoir (79,064 acre-feet), South Platte Intake Dam and the Highline Canal Diversion Dam.

The existing natural flows of the South Platte River are augmented by transmountain diversions by the Aurora-Homestake Project, Boreas Pass Ditch, and Roberts Tunnel diversion from Dillon Reservoir. The DWB uses the natural flows of the South Platte River under its water rights either by direct diversion to use or by storage in the DWB reservoirs previously identified and the Platte Canyon (941 acre-feet) and Marston (17,213 acre-feet) Reservoirs.

The levels of flow in the South Platte River are dependent on three factors - (1) natural runoff, (2) releases of stored water, and (3) transmountain diversions. Historical average monthly flows of the South Platte River at South Platte range from a low of 123 cfs in February to a high of 910 cfs in June (Table 2-11). Instantaneous flows higher than those shown on Table 2-11 have occurred, as shown in Table 2-14.

TABLE 2-14

SOUTH PLATTE RIVER (SPR) HISTORICAL DISCHARGE EXTREMES IN CFS

Location	Minimum	Date	Maximum	Date
SPR below Cheesman	1.6	4/28 - 14/57	4,640	4/29/70
At South Platte	10	12/5/99	6,320	6/8/21
At Waterton	0.1	3/6 - 7/33 2/28 - 3/2/38, 3/20/38	5,700	4/23/42

Natural runoff from melting snow accounts for most of the flow in May and June. High flows are sustained throughout July and August by releases of stored water and transmountain diversions. The average annual flow at various locations on the South Platte River and the North Fork of the South Platte River are shown in Table 2-13. Estimated frequency of flood peaks and volumes for the South Platte River at South Platte are presented in Table 2-15.

TABLE 2-15

ESTIMATED FREQUENCIES OF FLOOD PEAKS AND FLOOD VOLUMES
FOR THE SOUTH PLATTE RIVER AT SOUTH PLATTE, COLORADO, 1902-1971

Recurrence Interval (Years)	Peak Discharge (cfs)	Flood Volume (acre-feet)			
		1-Day	3-Day	7-Day	20-Day
2	1,440	2,530	7,250	15,400	39,200
5	2,380	4,360	12,200	25,900	65,500
10	3,190	5,960	16,700	35,600	87,500
25	4,440	8,350	23,600	50,100	118,800
50	5,540	10,550	29,700	63,200	144,500
100	6,800	12,770	36,400	77,600	173,300

Source: DWB 1973.

The average annual flow of the South Platte River at South Platte during the 1964-73 period was 298,000 acre-feet, including an average of 29,600 acre-feet of Roberts Tunnel System water. The DWB diverted about 117,700 acre-feet annually, including Blue River water, to meet demands for treated water at Kassler and Marston.

In addition, about 5,300 acre-feet of Homestake Project water (Aurora) and 300 acre-feet of Boreas Pass water (Englewood) is included in the South Platte River in the South Platte average annual flow during 1964-73. The Aurora-Homestake Project water is diverted at a location just upstream of the proposed Strontia Springs damsite to Aurora's Rampart Reservoir. The Englewood-Boreas Pass Ditch water is diverted from the South Platte River downstream of Chatfield Dam for treatment and use by that community.

A principal tributary of the South Platte River upstream of the proposed Strontia Springs damsite is the North Fork of the South Platte River. This tributary originates on the south slope of Mount Evans. From the east portal of Roberts Tunnel near Grant, Colorado, the stream flows approximately 33 miles before joining the South Platte River near South Platte, about 4.8 miles upstream from the proposed damsite and 24 miles downstream of Cheesman Dam.

The levels of flow in the North Fork of the South Platte River are dependent upon two factors - (1) natural runoff and (2) Roberts Tunnel diversions from Dillon Reservoir. Like the South Platte River, the North Fork experiences its lowest average monthly flows in February (58 cfs) and highest average monthly flows in June (490 cfs). High flows in May and June are primarily the result of snowmelt runoff. Relatively high flow levels are sustained through July and August by Roberts Tunnel diversions (Table 2-14).

The average annual flow of the North Fork of the South Platte River at Grant was 79,000 acre-feet and at South Platte was 143,500 acre-feet during 1964-73 (Table 2-16). The maximum instantaneous flow on the North Fork of the South Platte River at Grant was 990 cfs on June 7 and 8, 1912, and at South Platte it was 2,050 cfs on June 13, 1949. The largest release from the Roberts Tunnel of 433 cfs occurred during August 1976 and was maintained over a ten-day period.

Following completion of the Roberts Tunnel and Dillon Dam, the DWB essentially completed channel stabilization work along the 12.8-mile reach of the North Fork of the South Platte River between the east portal of the Roberts Tunnel and Bailey, Colorado. The design provided for the capability of sustaining flows of up to 680 cfs. The channel was designed for a peak discharge of 1,020 cfs at the beginning of the reach (Ecological Analysts, Inc. 1974). The additional channel capacity (a safety factor of about 50 percent) was provided for the anticipated but infrequent, short-lived periods when capability to pass flows of up to 1,020 cfs is required.

Types of works completed include control and check structures, bypass channels and relief conduits (to reduce flows in natural channels), channel riprapping where necessary and streambank revegetation.

Ground Water

Mountain ground water is usually a function of joint or fracture, density, and the degree of weathering along such openings. In a general way the ground water table follows the contours of the land surface at shallower grades. The water table approaches the surface in the canyon bottom, but is considerably deeper under the canyon walls (Board of Water Commissioners, Vol. II, 1973). Water seepage into rock fissures can be significant. Tests conducted by the DWB describe the capacity of fissures to pass water at various points of the canyon.

Standing water was not observed in any drill holes at the proposed treatment plant site. The soils and bedrock of the area are a mixture of clays and sandstone developed on the Pierre shale formation. The proposed treatment plant location is at the ground water recharge area of the outcropping sedimentary beds. The Pierre Formation is known as a poor aquifer, probably because of the high clay content and resulting poor permeability. Ground water levels in the formation would be low and relatively immobile. The water table would be encountered only at some increased depth, and when encountered, would not allow water to move through it, as would a more porous aquifer, such as the Fox Hills sandstone formation.

Water Quality

The chemical content of running water varies greatly and is a reflection of local geography and climate. Minerals have different solubilities, and various forms of aquatic life change the form of many dissolved substances. Water quality statistics for the South Platte River are limited to data collected for the past eight years by the Water Quality and Environmental Division of the DWB. Physical, chemical, and bacteriological data on the South Platte River and the North Fork are presented in Tables 2-16 and 2-17; these are the most complete data available. The data are derived from samples taken from the waters of the Kassler Treatment Plant river intake and the outlet of Dillon Reservoir. A comparison between the two sets of data indicates the waters are of similar quality.

Water hardness and alkalinity were medium in the study area; this is higher than normal for such streams. Nitrate exhibited normal trace amounts. Trace amounts of orthophosphate were higher than expected (DWB 1974).

Public Health Standards are stated in Table 1-10. The following factors affecting the quality of water occurred in lower concentrations than required by Public Health Standards: turbidity, total dissolved solids, nitrate, phosphate, chloride, sulfate, fluoride, iron, and manganese.

As the South Platte flows through Denver, treated wastewater is returned to the river. Water quality below the sewage outfalls is reduced considerably (EPA 1972). Biological oxygen demand and chemical oxygen demand are increased, as the result of inadequate wastewater treatment.

The Colorado Division of Wildlife has classified the South Platte River above Denver as B-1 cold water fishery stream. Standards required for a B-1 stream are listed in Table 2-18.

Present modified condition salinity concentrations of the Colorado River at Cameo, Colorado and Imperial Dam, Arizona (Bureau of Reclamation (BR) 1977) are 440 mg/1 and 861 mg/1, respectively.

TABLE 2-16

RAW WATER QUALITY FOR THE SOUTH PLATTE RIVER AT PLATTE CANYON INTAKE

Variable 1/	Maximum	Minimum	Average	No. of Analyses
Water temperature (deg. C)	22		9	--- 2/
Turbidity (JTU) 4/	70	1.5	8	--- 2/
Conductivity (microhms)	455	155	315	9
pH (S.U.) 5/	8	7.7	7.8	9
Total alkalinity	112	48	84.8	9
Total solids	285	92	183.5	6
Nitrate	0.15	0.02	0.07	5
Phosphate	0.11	0.03	0.06	7
Total hardness	162	62	118	11
Calcium	40.0	16.4	29.8	12
Magnesium	16.0	5.0	10.0	12
Sodium	34.6	18.4	26.0	7
Chloride	51.0	8.5	30.0	12
Sulfate	75.6	15.0	43.6	10
Fluoride	1.41	0.88	1.10	10
Iron	0.84	0.05	0.35	9
Manganese	0.15	0.01	0.05	9
Plankton (ml)	922	44	344	--- 3/

Source: DWB 1974

1/ Units are in milligrams per liter, except as noted otherwise.
2/ Temperature and turbidity have been obtained from daily records of Kassler Treatment Plant, August 1963 to May 1971.
3/ Plankton counts are average monthly figures of the Platte Canyon Reservoir for 1972 with diatomaceae as the most numerous species, followed by protozoa and chlorophyceae.
4/ Jackson Turbidity Units.
5/ Standard Units.

TABLE 2-17

RAW WATER QUALITY FOR DILLON RESERVOIR AT OUTLET

Variable 1/	Maximum	Minimum	Average	No. of Analyses
Water temperature (deg. C)	15	1	6.3	14
Turbidity (FTU) 2/	3.0	0.0	1.1	12
Conductivity (microhms)	310	100	166	15
pH (S.U.) 3/	8.0	7.1	7.5	17
Total alkalinity	96	30	56	17
Total solids	178	26	120	9
Nitrate	0.55		0.16	10
Phosphate	0.30		0.06	12
Total hardness	90	55	74	17
Calcium	29.2	16.0	21.3	18
Magnesium	7.3	2.3	5.0	18
Sodium	10.6	2.7	4.5	9
Chloride	20.0	0.2	5.5	16
Sulfate	52.0	15.6	32.0	15
Fluoride	0.84	0.35	0.52	13
Iron	0.24		0.09	12
Manganese	0.29		0.07	11
Plankton (ml)	---------------Not available------------			

1/ Units are in milligrams per liter, except as noted otherwise.
2/ Florescent Turbidity Units.
3/ Standard Units.

AQUATIC RESOURCES

In the Foothills Project area, the important aquatic habitats are located on the South Platte River, the North Fork of the South Platte River, and Dillon Reservoir.

Fish Populations

The South Platte River is well known as a productive trout stream. A comprehensive study of the fish population and bottom fauna was included as part of the environmental assessment of Waterton Canyon prepared for the DWB. The 9.7-mile study section was divided into three major easily defined study areas (Map 2-1) (DWB 1974). A description of them follow.

1. That portion of the river extending from the confluence of the South Platte and its North Fork to the Platte Canyon Intake Dam is a fast-flowing stream with an abundance of cover in the form of large boulders, some overhanging vegetation, and swift riffle areas.

2. That portion of the river extending from the Platte Canyon Intake Dam to the Highline Canal Diversion Dam suffers from water withdrawal, sand siltation, dredging operations, and the consequent destruction of prime aquatic habitat. Former road building encroachment has further changed the river ecology to a somewhat undesirable and unproductive level.

3. That portion of the river extending from the Highline Canal Diversion Dam to the Kassler Treatment Plant suffers from severe habitat destruction because of extreme water withdrawal, sand siltation, and earlier channelization or ditching.

Fish species found in the study area include rainbow trout, brown trout, and several species of non-sport fishes. Table 2-19 presents a summary of these fish species. There are no endangered species of fish known to inhabit the South Platte River.

TABLE 2-18

WATER QUALITY STANDARDS FOR THE SOUTH PLATTE RIVER, A B-1 COLD WATER STREAM

Standard	River Status
Settleable solids	Free from
Floating solids	Free from
Taste, odor, color	Free from
Toxic materials	Free from
Oil and grease	Cause a film or other discoloration
Radioactive material	Drinking water standards
Fecal coliform bacteria	Geometric mean of 1000/100 ml, 5 samples/30 days
Turbidity	No increase of more than 10 JTU
Dissolved oxygen	6 mg/l minimum
pH (S.U.) 1/	6.0 - 9.0
Temperature	Maximum 60 degrees F. Maximum change 2 degrees

Source: Colorado Department of Health, Water Quality Control Division 1974.

1/ Standard Units.

TABLE 2-19

FISH SPECIES IN THE WATERTON CANYON

Common Name	Scientific Name
Rainbow trout	*Salmo gairdneri*
Brown trout	*Salmo trutta*
Stoneroller	*Campostoma anonalum*
Longnose sucker	*Catostomus catostomus*
White sucker	*Catostomus commersoni*
River shiner	*Notropis blennius*
Bigmouth shiner	*Notropis dorsalis*
Sanshiner	*Notropis stramineus*
Fathead minnow	*Pimephales promelas*
Longnose dace	*Rhinicthys cataractae*
Creek chub	*Semotilus atromaculatus*

Source: DWB, Environmental Assessment, 1974.

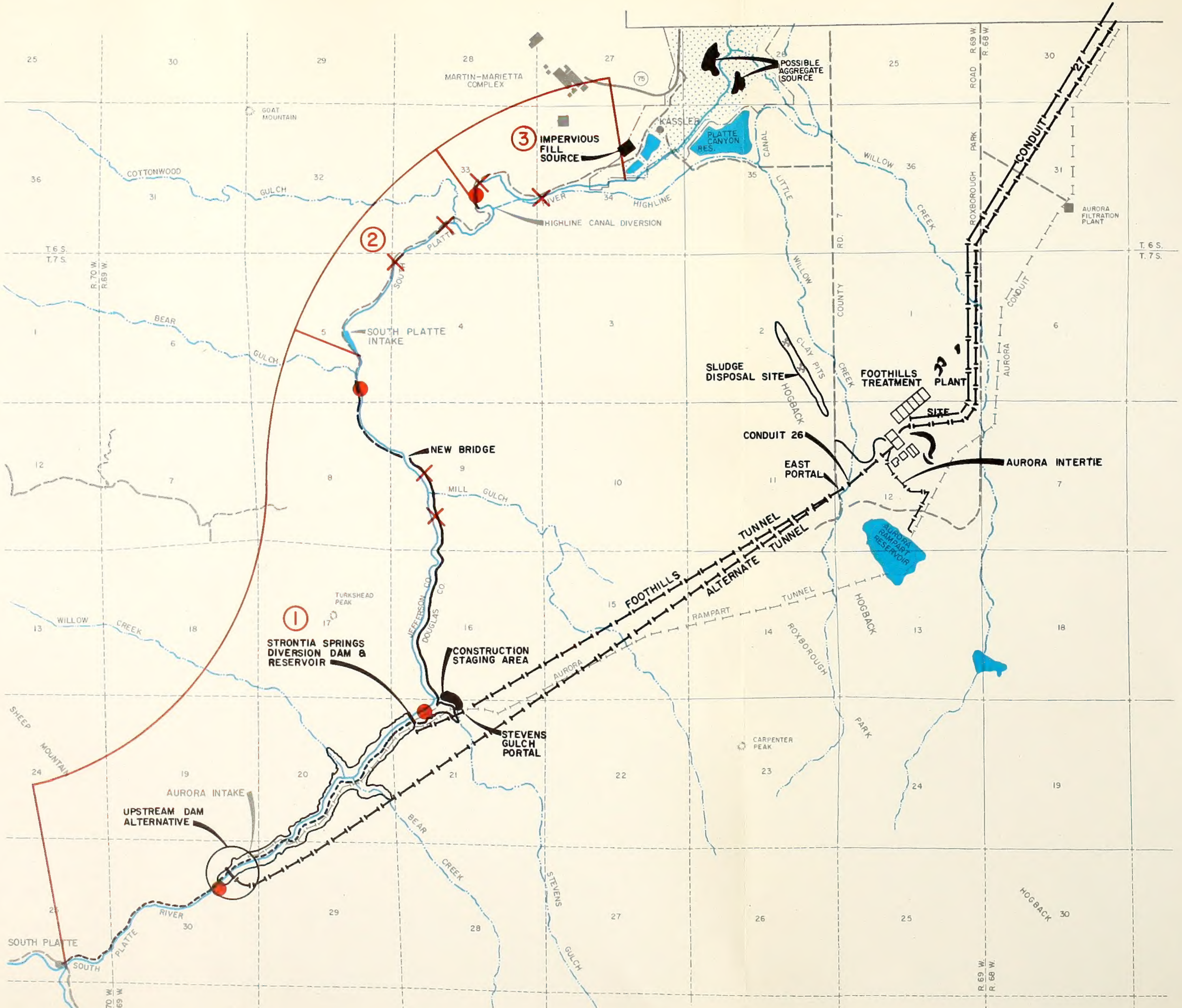
AQUATIC RESOURCES

LEGEND

③ STUDY AREA

● AMPHIBIAN POND

✕ FISH SAMPLING STATION



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0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-1

Despite the various disturbances to the aquatic environment of Waterton Canyon, the river is still a highly productive sports fishery (Table 2-20). Under present conditions, trout are able to migrate up and down the river to select the best possible spawning site. No information is available concerning the extent of this movement or to what degree it is essential for perpetuating fish populations. Existing diversion dams in the canyon do not seem detrimental to fish populations, but do curtail fish migrations. The river appears to be supporting a good population of brown and rainbow trout comparable to or exceeding other well known waters in Colorado (Table 2-21).

The sport fishery in the North Fork of the South Platte River is mainly sustained by stocking. Between 1973 and 1975 a total of 129,300 catchable size (6 inches plus) rainbow trout were planted in this stream between the old town of South Platte and the town of Grant. The population is supplemented to a limited extent by natural reproduction.

Prior to 1962, creel census data indicated four species of trout (rainbow, brook, brown, and cutthroat trout) were harvested by the fishermen in this area (DWB 1974). During the 1967 creel census, the cutthroat trout were not sampled, leaving three species of trout present in the North Fork of the South Platte River. By 1973, the brook trout had disappeared from the catch, leaving only the browns and rainbows. Detailed fish population data are not available for the North Fork.

Dillon Reservoir supports a trout and salmon fishery dominated by rainbow trout, which comprises 60 percent of the total fish population. Although natural reproduction is good in the tributary streams, the reservoir is also stocked on a regular basis. Each year, the Colorado Division of Wildlife operates a fish trap on the Blue River above Dillon Reservoir to take eggs from the brown trout for use in their hatchery system. Recent improvements to Tenmile Creek to provide fish habitat should increase natural recruitment into the reservoir. The fishery is rated as being of State and local importance; however, there has been concern over the excessive growth of rooted aquatics in the Blue River arm of the reservoir.

Data concerning species composition and distribution of the invertebrate population, the aquatic vegetation and amphibians for Dillon Reservoir are not available at this time.

Bottom Fauna

The bottom fauna sampling from the three sites (upstream of, within, and downstream from the proposed reservoir) revealed eight major groups of organisms (Table 2-22); mayflies, stoneflies, and caddisflies constituted 79 percent of the total species.

TABLE 2-20

POPULATION ESTIMATE FOR BROWN AND RAINBOW TROUT IN THE WATERTON CANYON FOR SUMMER AND FALL, 1973

Study Section and Trout Species	Population Estimate	Population Estimate for Total Area 1/	Number of Fish per Surface Area	Pounds of Fish per Surface Area
1. Brown	157	10,833	319	52
Rainbow	27	1,863	55	12
Total		12,696	374	64
2. Brown	136	2,441	276	43
Rainbow	76	1,368	154	35
Total		3,809	430	78
3. Brown	77	1,217	156	37
Rainbow	----No Estimate ----------			
Total		1,217	156	37

Source: DWB, Environmental Assessment, 1974.

1/ Estimates are based on backpack electrofishing of 500-foot study sections and using the Peterson mark-recapture index for population estimates.

TABLE 2-21

POPULATIONS OF BROWN AND RAINBOW TROUT
IN THE LOWER SOUTH PLATTE RIVER
AS COMPARED WITH POPULATION OF OTHER WATERS (1974)

Location in Colorado	No. of Fish per Acre	Pounds of Fish per Acre	Reference
Lower South Platte River 1/	35 @ 2 lb.	71.3	DWB, Environmental Assessment, 1974, Appendix A, p. A-15
Upper South Platte River 2/	360 @ .17 lb.	61.4	U.S. Department of the Interior F&WS 1975a, p. 13
Cache la Poudre River 3/	215 @ .30 lb.	65.0	Colorado Department of Natural Resources, 1974b
Frying Pan River	156 @ .83 lb.	128.9	Colorado Department of Natural Resources, 1974a
Roaring Fork River	340 @ .8 lb.	271.0	Colorado Department of Natural Resources, 1972
Big Thompson River	744 @ .16 lb.	120.3	U.S. Department of the Interior, F&WS, 1972

1/ This location is downstream from the confluence with the North Fork of the South Platte.

2/ This location is upstream of the confluence with the North Fork of the South Platte.

3/ These data include only trout six inches long, or greater.

TABLE 2-22

MEAN NUMBER OF ORGANISMS PER SQUARE METER
SOUTH PLATTE RIVER, MARCH 15, 1973 TO MAY 17, 1973

Common Name	Order	Number at Site 1	Site 2	Site 3
Mayfly	Ephemeroptera	400	281	396
Stonefly	Plecoptera	62	38	41
Caddisfly	Trichoptera	145	142	233
True Fly	Diptera	78	79	157
Beetle	Coleoptera	20	22	48
Dragonfly	Odonata		3	3
Segmented worm	Annelida	3	26	12
	Mematomorpha		2	2

Source: Ward 1974.

Bottom fauna sampling data from the unchannelized portion of the North Fork indicate five major groups of organisms are present (Table 2-23). By number, mayflies, stoneflies, and caddisflies constituted 94 percent of the total species.

The three dominant orders found in each stream are very often restricted to the clean water environment and compose a large portion of the organisms in any such environment (Ganfin 1973).

Aquatic Vegetation

Flowering plants (aquatic angiosperms) are not known to occur in the proposed project area of the North Fork and South Platte Rivers. The scouring action of the water and sand prevents these rooted aquatic plants from becoming established.

Amphibians

Amphibians are known to breed in temporary ponds along the existing road in the lower reaches of the canyon. Table 2-24 presents a species checklist of amphibians found in Douglas and Jefferson Counties and a notation of species found in or near the proposed project area. Map 2-1 shows the locations of the four known amphibian ponds. No information is available concerning amphibians on the North Fork.

GEOLOGY, MINERALS, AND TOPOGRAPHY

Topography and General Geology

In the proposed Foothills Project area the South Platte River flows across two distinctly different geologic provinces, which are regions with grossly similar geology. The South Platte River flows from its source along the Continental Divide in the Mosquito Range, then flows eastward toward Denver, crossing sedimentary rocks. From the head of the river to Kassler, the river flows across crystalline igneous and metamorphic rocks of the southern Rocky Mountain physiographic province (Fenneman 1931). From Kassler through Denver and beyond, the South Platte flows across the flat-lying sediments of the Great Plains province (Fenneman 1931).

TABLE 2-23

DENSITY AND BIOMASS OF ORDERS OF ORGANISMS PER SQUARE METER
NORTH FORK, MARCH 29, 1974

Common Name	Order	Density/m2	Grams/m2
Mayfly	Ephemeroptera	422	1.7
Stonefly	Plecoptera	69	1.3
Caddisfly	Trichoptera	175	2.0
True Fly	Diptera	33	1.0
Bettle	Coleoptera	10	less than 0.1

Source: DWB, Environmental Assessment, 1974.

TABLE 2-24

AMPHIBIANS FOUND IN JEFFERSON AND DOUGLAS COUNTIES

Common Name		Scientific Name
Barred Tiger Salamander	Caudata:	Ambystoma tigrinum mavortium
Rocky Mountain Toad 1/	Anura:	Bufo woodhousei woodhousei
Boreal Chorus Frog		Pseudacris triseriata maculata
Bullfrog		Rana catesbeiana
Western Leopard Frog 1/		Rana pipiens brachycephala
Plains Spadefoot 1/		Spea bombifrons

Source: Smith, H.M. et al 1965, for DWB 1974.

1/ The Rocky Mountain Toad (Bufo woodhousei woodhousei) and the Western Leopard Frog (Rana pipiens brachycephala) are found in the lower canyon, not in the study site. Both use temporary ponds along the canyon, below the study site, as breeding sites.

2/ Found in Douglas County only.

Alluvium is sparse within the Waterton Canyon with the narrow deposits along the canyon floor. Alluvium deposits as much as 20 feet thick, composed predominantly of pebbles and cobbles derived from local rock, occur in the canyon (U.S. Geological Survey (USGS) 1964.)

Near the east end of the Waterton Canyon the river passes from crystalline terrain to sedimentary rocks. Along the eastern flank of the mountains these rocks are warped upward to form hogback ridges. These landforms are breached by the river as it crosses onto the Great Plains physiographic province. The geology of the area is thoroughly described in several works listed in the bibliography (USGS 1963a, 1963b, 1964c).

Geologic Processes

The South Platte river carries a streamload equal to 70,000 tons (36 acre-feet) of sediment annually past any given point in the Waterton Canyon. The streamload is the solid material actually transported by a stream, either as visible sediment (carried in suspension or moved along the streambed by saltation and traction), or in chemical or colloidal solution (Gary and Wolf 1972). Anytime the velocity of a stream carrying its optimum load of sediment diminished, a portion of that load settles out (Krynine and Judd 1957). Under natural conditions, this process is continually taking place; material is picked up as rapid flow increases the stream's capacity to hold sediment and is deposited where eddies or natural obstructions slow the flow of the stream. When rapidly flowing river water enters a reservoir, its velocity decreases, causing sediment to settle out. As sediment continues to be deposited, it displaces water in the reservoir until there is little storage space for water remaining behind the dam.

In addition, this capture of sediment by the reservoir removes material that otherwise would be carried downstream and deposited elsewhere. Thus, water flowing downstream of the dam contains much less than its optimum load of sediment. In reaches of the river below the dam there is an increase in bank erosion as the river again acquires its optimum load of sediment. Before it acquires its optimum load again, it is in a condition of streamload imbalance.

Presently, there are two structures in the Platte Canyon that cause a streamload imbalance in the river. These are the Platte Canyon Intake Dam and the Highline Canal Diversion Dam. To offset the imbalance, and also to allow continued operations, the Platte Canyon Intake Dam is periodically flushed and the Highline Canal Diversion Dam is draglined to remove accumulated sediments (DWB 1974).

Minerals

Anomalies of radium and radon concentrations in spring water issuing from faults in Stevens Gulch (N 1/2 Sec. 21, T7S, R69W) suggest slight concentrations of uranium (USGS 1963b). The presence of uranium can also be inferred geologically, although no deposits have actually been discovered within the project area.

In the area near the treatment plant site, both limestone, sand and clay have been quarried. At present, although no operations are active, a quarry in the SE 1/2 Sec. 2, 17S, R69W from which "quite pure" limestone was mined operated on at least a part-time basis in 1963 (USGS 1963b).

Geologic Hazards and Problem Areas

Faults, Joints, Seismic Activity, and Earthquake Hazard

Determining the ages of movement of faults in the South Platte Canyon is quite difficult since no rocks younger than Precambrian are present. Precambrian faults were present and many were reactivated or mineralized during the Laramide Revolution. New faults were also developed during this period. How much movement has taken place along these faults since the Laramide is not known. In the case of the Kennedy Gulch Fault, however, 300 meters of displacement has occurred since the beginning of Oligocene Time (40 million years ago).

Faulting of the crystalline rocks is evident and a shear zone underlies and is adjacent to the dam site. Certain engineering techniques will be used to compensate for this problem. Generally, the faults have a northwest trend with an easterly dip. Some faults consist of broad shear or fracture zones. The most notable fault is the Willow Creek, which strikes approximately west-northwest. The course of Willow Creek follows the fault very closely. Bear Gulch, Cottonwood Gulch and an unnamed drainage north of Cottonwood Gulch are all well developed and follow faults parallel to the Willow Creek fault. Several faults which trend (strike) in a northeast direction are considerably less well developed than are the northwest trending faults. The northwest trending fault system predominates in the metamorphics and roughly parallels the foliation (resembling bedding planes in sedimentary rocks) of the rock unit. The northeast-trending system appears to radiate from some point southwest of the town of South Platte.

Although the historical seismicity of Colorado is fairly low (Simon 1969), the record is too short to provide an accurate assessment of the earthquake hazard of the State. Several lines of geologic evidence suggest that the seismicity of several parts of Colorado may be considerably higher than indicated by the scanty historical record (Scott 1970; Mathews 1973; Kirkham 1977; Colorado Geological Survey 1974).

Quaternary fault displacements indicate the occurrence of large earthquakes and would be valuable in appraising the likelihood of future earthquakes in the area. The existence of Quaternary ruptures shows that Colorado has had earthquakes in Quaternary time. These earthquakes were large because a magnitude of about 6.5 (Richter scale) is generally considered necessary to cause surface rupturing of rocks (Scott 1970). However, with one possible exception in 1882, no earthquakes of this magnitude have occurred in Colorado in 100 years of recorded history. The Golden Fault, whose expression can be traced south to twelve miles north of the treatment plant, is the fault nearest the area showing Quaternary displacement. The Golden Fault has a long history of movement, beginning probably during the Laramide revolution and producing at least 18 feet of movement during Quaternary Time. Resulting earthquakes were probably at least Magnitude VII on the Modified Mercalli Scale, which is described as: everybody runs outdoors; damage to buildings varies, depending on quality of construction; noticed by drivers of autos.

According to the DWB Foothills predesign study, two sets of regional joints or fractures exist near the dam site. One set trends in a general north-south direction and has steep dips (inclination of the plane of the joint) ranging from 70 degrees west through vertical to 70 degrees east. The second set strikes west-northwest, approximately parallel to the foliation, but exhibits southward dips opposed to those of the foliation and ranging mostly from 40 to 65 degrees. The north-south joint set appears more prominently in surface outcrops.

Shearing is evident both in surface outcrops and in cores recovered from boreholes. Shearing is defined as: joints exhibiting some small amount of varying movement of the rock masses parallel to the plane of the joint (usually several parallel joints are involved). However, the sheared zones (several parallel shears) are only a few feet wide and each appears to be of limited extent.

Slides and Rock Falls

The foliation of the metamorphic rocks of the Platte Canyon strikes roughly northwest. The foliation is distinguished by bands of light and dark-colored minerals, often no more than a quarter inch thick. The foliation planes are considered planes of weakness along which an unsupported rock mass can fail or slide (Board of Water Commissioners, Vol. II, 1973). In the canyon the weathered material (rock debris and soil) forms a thin cover over solid unfractured rock. There is little probability of devastating landslides even though the canyon walls are quite steep; however, because the overlying weathered rock is highly fractured, there is an ever-present possibility of falling rocks. Small rock falls are probably more common than larger rock falls.

Some of the sedimentary beds east of the Dakota hogback contain a considerable amount of clay and, when saturated, could become fluid enough to move downslope. Natural slopes in that area are probably in relative equilibrium and should not slide if the vegetative cover and natural slopes are not disturbed. However, in sediments on the flanks of the pediments, landslides can be observed on 25-degree slopes at several places in the Pierre Shale (USGS 1963b).

SOILS

The soils or combination of soils shown on Maps 2-2, 2-3, and 2-4 occur within the area of proposed action. These maps show the geographical location of these soils as it related to the proposal. This soils data is from the Soil Survey of Castle Rock Area, Colorado (Soil Conservation Service (SCS) 1974), and the Soil Survey of Arapahoe County, Colorado (SCS 1971), and the Soil Survey of the Golden Area (SCS 1977).

Soil Descriptions and Interpretations

Soil descriptions and interpretations are illustrated by soil units and associations from referenced soil surveys and are available from SCS, Colorado State Office in Denver, Colorado.

From observing the work which was done by the City of Aurora when installing its water facilities in the Foothills project area, natural productivity of the soil did not affect the re-establishment of vegetation in areas that were disturbed. No fertilizer or additional water was needed to establish a ground cover. The precipitation was sufficient for plant establishment. Table 2-25 contains estimates of soil properties that are of special concern as they are related to this proposal.

Sediment Yields

Sediment yield is defined as the average amount of sediment from a square mile transported by water from its source area into local water courses. This represents a long time average over as much as 25 years or more. A great deal of the quantitative data used to determine these yields were from dry reservoirs and as a result reflect the average weight of volume of sediment deposited in these reservoirs.

[illegible] textured soils [illegible] of the [illegible] topsoil, containing considerable amounts of clay [illegible] enough to [illegible] [illegible] in [illegible] [illegible] [illegible] of the [illegible] [illegible] in the [illegible] [illegible].

SOILS

[illegible] soils [illegible] occur within the area of proposed action. [illegible] general location of these soils as it relates to the proposal. [illegible] Soils data is from the Soil Survey of Castle Rock Area, Colorado (Soil Conservation Service (SCS) [illegible]) and the Soil Survey of [illegible] (SCS [illegible]) and the Soil Survey of the [illegible] Area (SCS [illegible]).

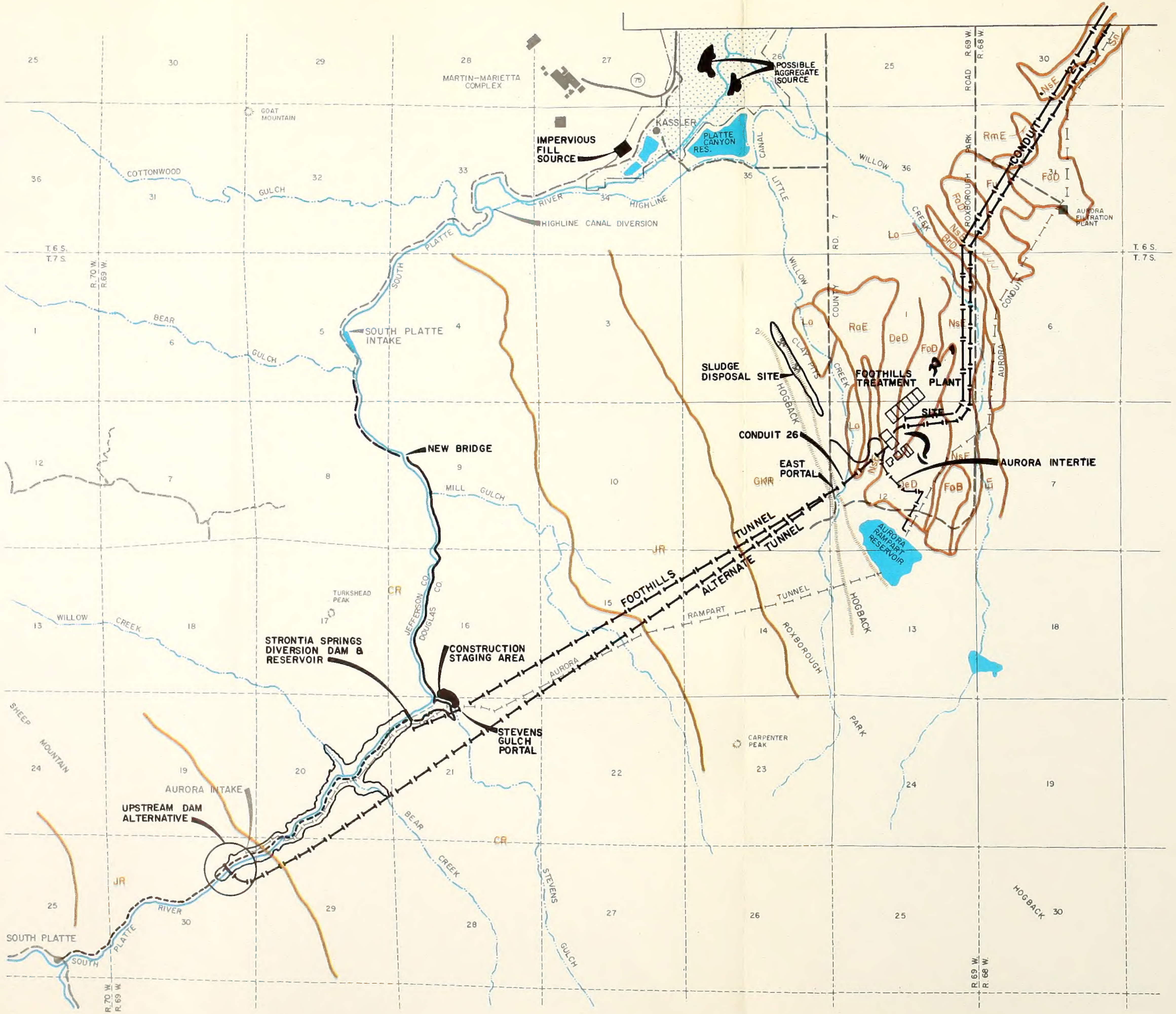
<u>Soil Descriptions and Interpretations</u>

Soil descriptions and interpretations are illustrated by soil series and [illegible] soil surveys and are available from SCS, Colorado State Office in Lakewood, Colorado.

[illegible] productivity of the soil did not affect the [illegible] tation in areas that were disturbed. No fertilizer or additional water was needed to establish a ground cover. The precipitation was sufficient for the plant establishment. Table 3-[illegible] contains evaluations of soil properties that are of special concern as they are related to this proposal.

<u>Sediment Yield</u>

Sediment yield is defined as the average amount of sediment from a square [illegible] [illegible] This represents [illegible] [illegible] yield [illegible] weight of [illegible]



SOILS

Legend — Douglas Co. (Castle Rock Survey Area)

Map Symbol	Soil Unit
*BrB	Bresser sandy loam, (1-3% slopes)
BrD	Bresser sandy loam, (3-9% slopes)
DeD	Denver clay loam, (5-12% slopes)
En	Englewood clay loam, (1-4% slopes)
FoD	Fondis clay loam, (3-9% slopes)
*FdB	Fondis silt loam, (1-3% slopes)
*FdC	Fondis silt loam, (3-5% slopes)
FoB	Fondis clay loam, (1-3% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RaE	Razor clay, (3-25% slopes)
*Sn	Satanta loam, (1-4% slopes)
Fu	Fondis-Kutch
NsE	Newlin-Satanta complex, (8-30% slopes)
RmE	Renohill-Buick complex, (5-25% slopes)

General Soil Associations

GKR	Garber-Kassler-Rockland
JR	Juget-Rockland
CR	Cryoboralf-Rock Outcrop
	Outcropping

*Prime Agricultural Soils (Regional Classification)
Hill, Gayle. Denver Regional Council of Governments. Criteria for Specification of Primary Agricultural Lands, November, 1976 (Draft)
Prime agricultural lands are classified as the most productive lands in this region, irrigated or non-irrigated.

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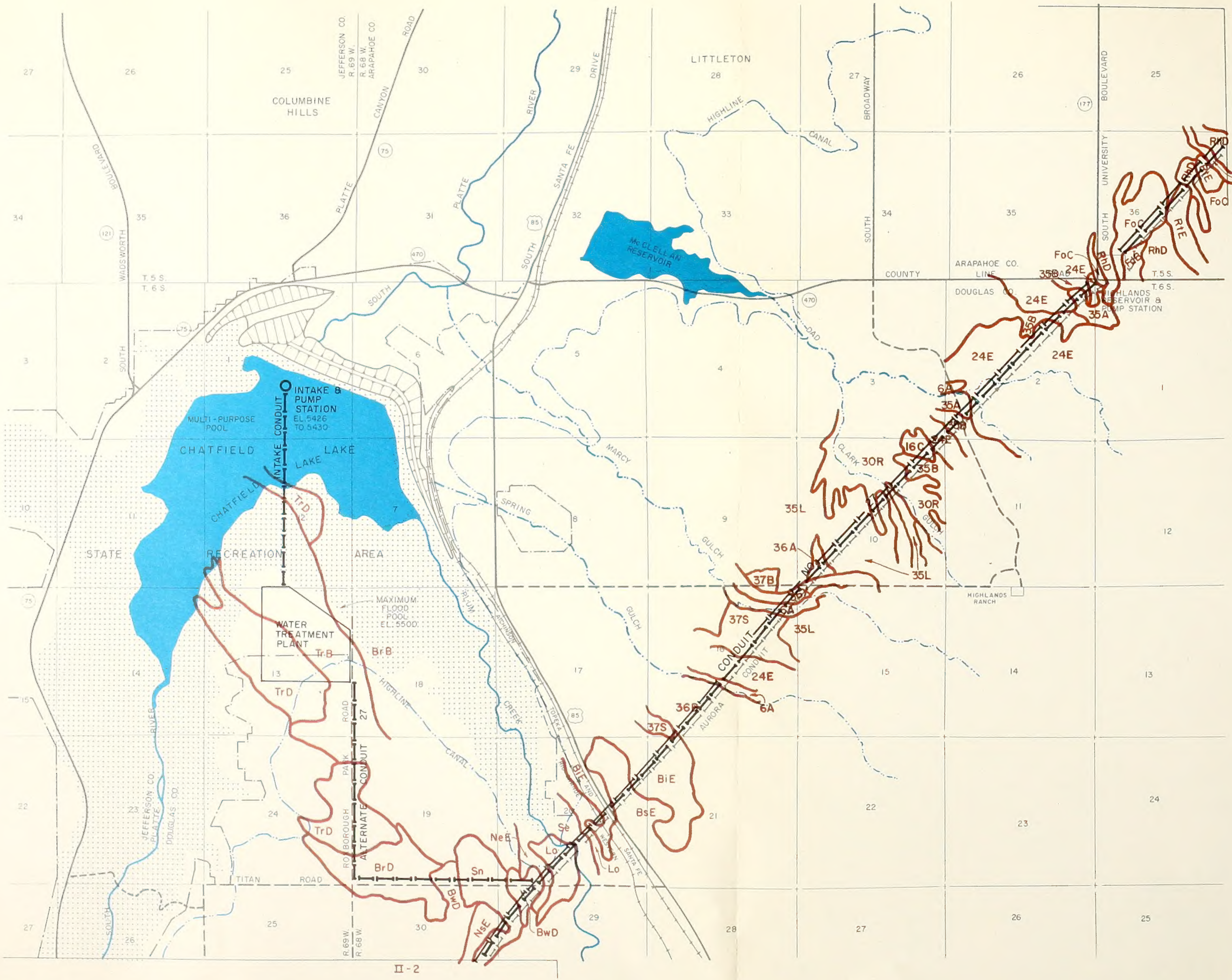
0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

MAP - FOOTHILLS

MAP 2-2



SOILS

Legend	Arapahoe Co. Soil Survey
Map Symbol	**Soil Unit**
* FdB	Fondis silt loam, (1-3% slopes)
* FoC	Fondis-Colby complex, (3-5% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RhD	Renohill-Buick, (3-9% slopes)
RtE	Renohill loam, (9-20% slopes)
Tc	Terrace Escarpment
	Douglas Co. (Castle Rock Survey Area)
BiE	Blakeland sandy loam, (1-15% slopes)
* BrB	Bresser sandy loam, (1-3% slopes)
BrD	Bresser sandy loam, (3-9% slopes)
BsE	Bresser-Louviers complex, (7-30% slopes)
BwD	Buick-Satanta loam, (3-9% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
Se	Sandy wet alluvium, (1-5% slopes)
* Sn	Satanta loam, (1-4% slopes)
NeE	Newlin gravelly sandy loam, (8-30% slopes)
NsE	Newlin-Satanta complex, (5-20% slopes)
* TrB	Truckton sandy loam, (1-3% slopes)
TrD	Truckton sandy loam, (3-8% slopes)
	Douglas Co. Phipps Ranch portion (Golden Soil Survey Area)
6A	Fluventic Haplustoll, loamy, (0-2% slopes)
16C	Ulm clay loam, calcareous surface, (5-9% slopes)
24E	Renohill-Buick clay loam, (9-15% slopes)
30R	Ulm-Renohill clay loam, (9-15% slopes)
* 35A	Fondis clay loam, (0-3% slopes)
35B	Fondis clay loam, (3-9% slopes)
35L	Fondis loam, (3-9% slopes)
* 36B	Blakeland loamy sand, (0-3% slopes)
36X	Blakeland-Orsa complex, (9-15% slopes)
37B	Truckton loamy sand, (3-9% slopes)
* 37S	Truckton sandy loam, (3-9% slopes)

* Prime Agricultural Soils (Regional Classification)

Hill, Gayle. Denver Regional Council of Governments. Criteria for Specifications of Primary Agricultural Lands. November, 1976 (Draft). Prime Agricultural Lands are classified as the most productive lands in this region, irrigated or non-irrigated.

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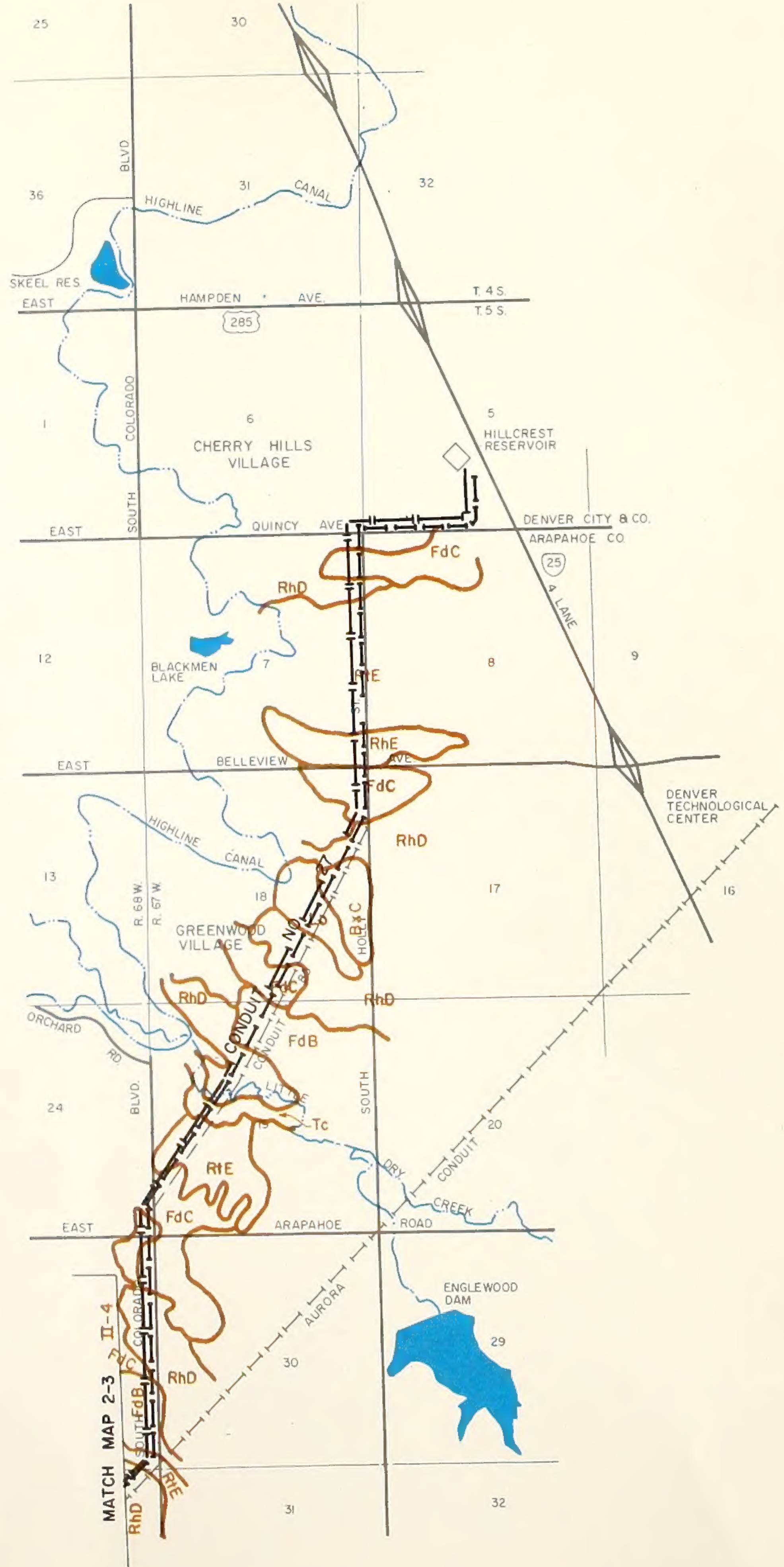
0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

MAP - HIGHLANDS RESERVOIR

MAP 2-3

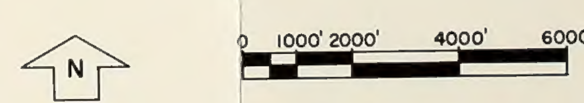


SOILS

Legend   Arapahoe Co. Soil Survey

Map Symbol	Soil Unit
BxC	Buick loam, (3-5% slopes)
*FdB	Fondis silt loam, (1-3% slopes)
*FdC	Fondis silt loam, (3-5% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RhD	Renohill-Buick, (3-9% slopes)
RhE	Renohill loam, (9-20% slopes)
RtE	Renohill-Litle-Thedalund, (9-30% slopes)
Tc	Terrace Escarpment

*Prime Agricultural Soils (Regional Classification)
Hill, Gayle. Denver Regional Council of Governments. Criteria for Specification of Primary Agricultural Lands, November, 1976 (Draft)
Prime agricultural lands are classified as the most productive lands in this region, irrigated or non-irrigated.



DESCRIPTION OF THE ENVIRONMENT

MAP - HILLCREST RESERVOIR
MAP 2-4

The sediment yields for this area were derived from the 1974 Colorado sediment yield map (Colorado Land Use Commission and the Soil Conservation Service 1974) and are in the low yield category, ranging from 0.1 to 0.2 acre-feet per 640 acres per year (Table 2-25). This would amount to approximately 1/2 ton per acre per year using the midpoint of the indicated yield. It is estimated that sediment yield from disturbed soils increases to a point where it falls within the upper parameter of the high yield category, shown by Table 2-25. At a rate of 1.0 acre-foot per 640 acres per year, this is equivalent to a yield of approximately 3 tons of sediment per acre per year.

To convert acre feet per square mile per year to tons per acre per year in sediment yield calculations, the following procedure was utilized. The midpoint of the low yield class from the Colorado Land Use Commission and SCS sediment yield map (0.15 acre feet per square mile per year) was estimated to be representative of the area of this proposal. The 0.15 acre feet per square mile per year was converted to cubic feet per square mile per year by multiplying 43,560 cubic feet (number of cubic feet in one acre-foot) by 0.15, which is equal to 6,534 cubic feet per square mile per year of sediment yielded. The 6,534 cubic feet per square mile was converted to cubic yards per square mile per year by dividing this number by 27 cubic feet (27 cubic feet = 1 cubic yard), resulting in a sediment yield of 242 cubic yards per square mile per year. In order to reduce this to cubic yards per acre per year, the 242 cubic yards was divided by 640 acres (number of acres within a square mile). This is equivalent to 0.38 cubic yards per acre per year. In order to obtain tons per acre per year, the 0.38 cubic yards was multiplied by 1.2 tons (the estimated weight of a cubic yard of sediment that would be yielded from the area), resulting in an estimated sediment yield of 0.456 tons per acre per year, which was rounded off to 0.5, or 1/2 tons per acre per year.

The same procedure was used in covering the 0.1 foot per square mile per year, which was estimated to be the yield after disturbance under this proposal.

TERRESTRIAL RESOURCES

Vegetation

The proposed Foothills Project involves three broad vegetative zones. The location of the proposed treatment plant and conduits is a short grass grassland within the Northern Temperate Grassland of North America (Shelford 1963). Waterton and the surrounding area is classified as lower montane (Marr 1967) of the Boreal Montane Coniferous Forest in North America (Shelford 1963). The North Fork above Bailey is classified

TABLE 2-25

ESTIMATED SOIL PROPERTIES

Soil	Soil Reaction	Salinity (millimhos/cm) 1/	Shrink Swell Potential	Corrosivity		Depth From Surface in Inches	Classification		Hydrologic Soil Group
				Steel	Concrete		Unified	ASSHTO	
Blakeland	6.1-7.8	Slight (0-2)	Low	Low	Low	0-60	SMar SP-SM	A-3	A
Bresser	6.7-7.8	None to slight	Low to moderate	Low	Low	0-5 5-30 30-60	SM SC or CL SM	A-2 A-4 or A-6 A-2	B
Buick	6.8-8.0	None	Moderate to high	High	Low	0-22 22-56	CL CL	A-6 or A-7 A-1	C
Colby	7.5-9.0	Slight to moderate	Low	Low	Low	0-60	CL-ML, or CL or ML	A-4 or A-6	B
Denver	6.1-9.0	Slight (2-4)	High	High	Low	0-55	CH or CL	A-7	C
Englewood	6.6-9.0	Moderate	High	--	--	0-60	CH or CL	A-6 or A-7	C
Fondis	6.4-7.15	Slight to moderate	Moderate	--	--	0-24 24-60	CH SC	A-7 A-7	C
Kutch	6.1-8.4	Moderate	Moderate to high	High	Moderate	0-32	CL or CH	A-6 or A-7	D
Litle	7.5-8.5	Slight	High	High	Low to moderate	0-39	CH	A-7	D
Louviers	6.1-7.8	Slight (0-2)	High	Low	Low	0-12	CL or CH	A-6 or A-7	D
Newlin	6.1-7.8	Slight (0-2)	Low	Moderate	Low	0-22	SM or GM	A-1 or A-2	B
Razor	7.3-9.0	Moderate (4-8)	High	High	Low	0-34	CH	A-7	D
Renohill	5.6-7.3	Slight (0-2)	Moderate	High	Moderate	0-24	CL or CH	A-6 or A-7	C
Satanta	5.6-8.4	Slight (0-4)	Low	Low	Low	0-30 30-60	CL ML	A-6 A-4	C
Thedalund	7.5-8.5	Slight	Low	High	Low	0-30	CL	A-7	C
Truckton	6.1-7.5	Slight (0-2)	Low	Low	Low	0-60	SM	A-2 or A-4	B
Loamy alluvial lands	6.1-8.4	Slight (0-4)	Low to moderate	--	--				
Sandy wet alluvium	6.1-8.4	Slight to moderate	Low	--	--				
Terrace escarpment	---------------------------No Data---------------------------------------								

Source: SCS and Colorado Land Use Commission

1/ Measure of electrical conductivity

as upper montane. These three broad vegetative zones are transected by a riparian subtype, creating four basic plant communities (Map 2-5). Detailed species lists and information on the occurrence of species in the project area are available from BLM, Denver, Colorado. Environmental Assessment, Foothills Project, Denver Water Board, by Ecological Analysts Inc., supplies species lists and maps for specific ecology in the Foothills area.

The native grasslands zone that occurs on the rolling plains east of the foothills is characterized by mixed stands of buffalo grass, blue gramagrass, western wheatgrass, green needlegrass, sedges, Kentucky bluegrass, fringed sage, prickly pear cactus, and yucca; however, the species composition is dominated by blue grama and buffalo grass. Although annual forbs are common during early spring, they comprise only a small portion of the vegetation. The native plant composition has been greatly modified in many areas of the grassland by heavy livestock grazing, cultivation, and introduction of weedy species such as cheatgrass. Data are not available to quantify forage production in the grassland area; however, the area probably produces 800 pounds of dry forage per acre in average years. About 2.2 acres of this forage could support one cow for one month.

Trees and shrubs are not common in the local grassland zone except along stream courses where cottonwoods and willows occur in narrow bands. Tracts of land that have been plowed and farmed are included in the grassland area; small grains and permanent pasture are common domestic crops.

The montane zone is characterized by mixed stands of Gambel's oak, mountain mahogany, snowberry, mountain maple, ponderosa pine, mountain juniper and Douglas-fir. The understory vegetation and grassy areas consist of mountain muhly, Parry oatgrass, bluejoint, bluegrass, Scribner's needlegrass and various forbs.

Gambel's oak and mountain mahogany occur throughout the foothills area; however, these shrubs dominate the aspect of south-facing slopes and the lower portion of Waterton Canyon. The shrub-covered hillsides support a sparse stand of mountain juniper and ponderosa pine trees. Douglas-fir, occurring in scattered, isolated stands in the lower reaches of the canyon, forms a dominant part of the vegetative aspect of the upper canyon (Map 2-6). Dense stands of Douglas-fir usually occur in pockets on the north- and northwest-facing slopes, although scattered trees exist throughout the steep-walled Waterton Canyon. Small clearings or openings in the brush and timber support a variety of grasses and forbs.

To estimate relative amounts of timber, brush, riparian, and grassland vegetation in the Waterton Canyon, acreages of each vegetative type were estimated, using aerial photos and USGS topographic maps for an area lying 1/2 mile on each side of the river along the eight miles

as upper montane. These three broad vegetative zones are dominated by a singular ecotype, creating four basic plant communities (Map 3-9). Detailed species lists and information on the occurrence of species in the project area are available from ERT, Boulder, Colorado. Environmental Assessment, Foothills Project, Denver Water Board, by Ecological Consultants Inc., including species lists and maps for specific locales in the Foothills area.

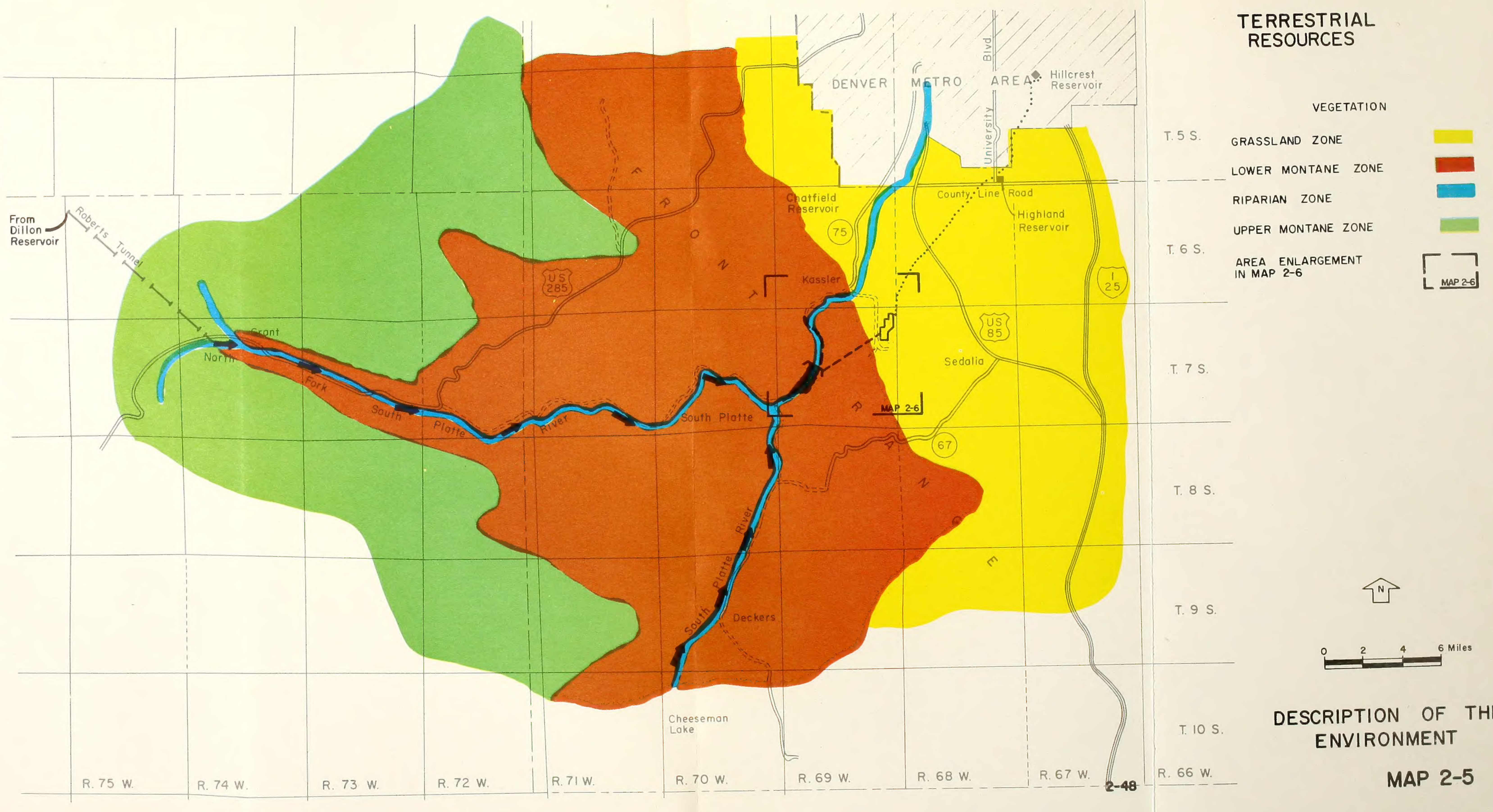
The native grasslands zone that occurs on the rolling plains areas of the foothills is characterized by mixed stands of buffalo grass, blue grama grass, western wheatgrass, green needlegrass, yellow, Kentucky bluegrass, fringed sage, prickly pear cactus, and yucca; however, the species composition is dominated by blue grama and buffalo grass. Although annual forbs are common during early spring, they constitute only a small portion of the vegetation. The native plant composition has been greatly modified in many areas of the grassland by heavy livestock grazing, cultivation, and introduction of weedy species such as cheatgrass. Data are not available to quantify forage production in the grassland areas; however, the area probably produces 800 pounds of dry forage per acre in average years. About 5.0 acres of this forage would support one cow for one month.

Trees and shrubs are not common in the local grassland zone except along stream courses where cottonwoods and willows occur in narrow bands. Tracts of land that have been plowed and fenced are included in the grassland areas; small grains and permanent pasture are common domestic crops.

The montane zone is characterized by mixed stands of Gambel's oak, mountain mahogany, snowberry, mountain maple, ponderosa pine, mountain juniper and Douglas-fir. The understory vegetation and grassy areas consist of mountain muhly, Parry oatgrass, bluestem, bluegrass, Scribner's needlegrass and various forbs.

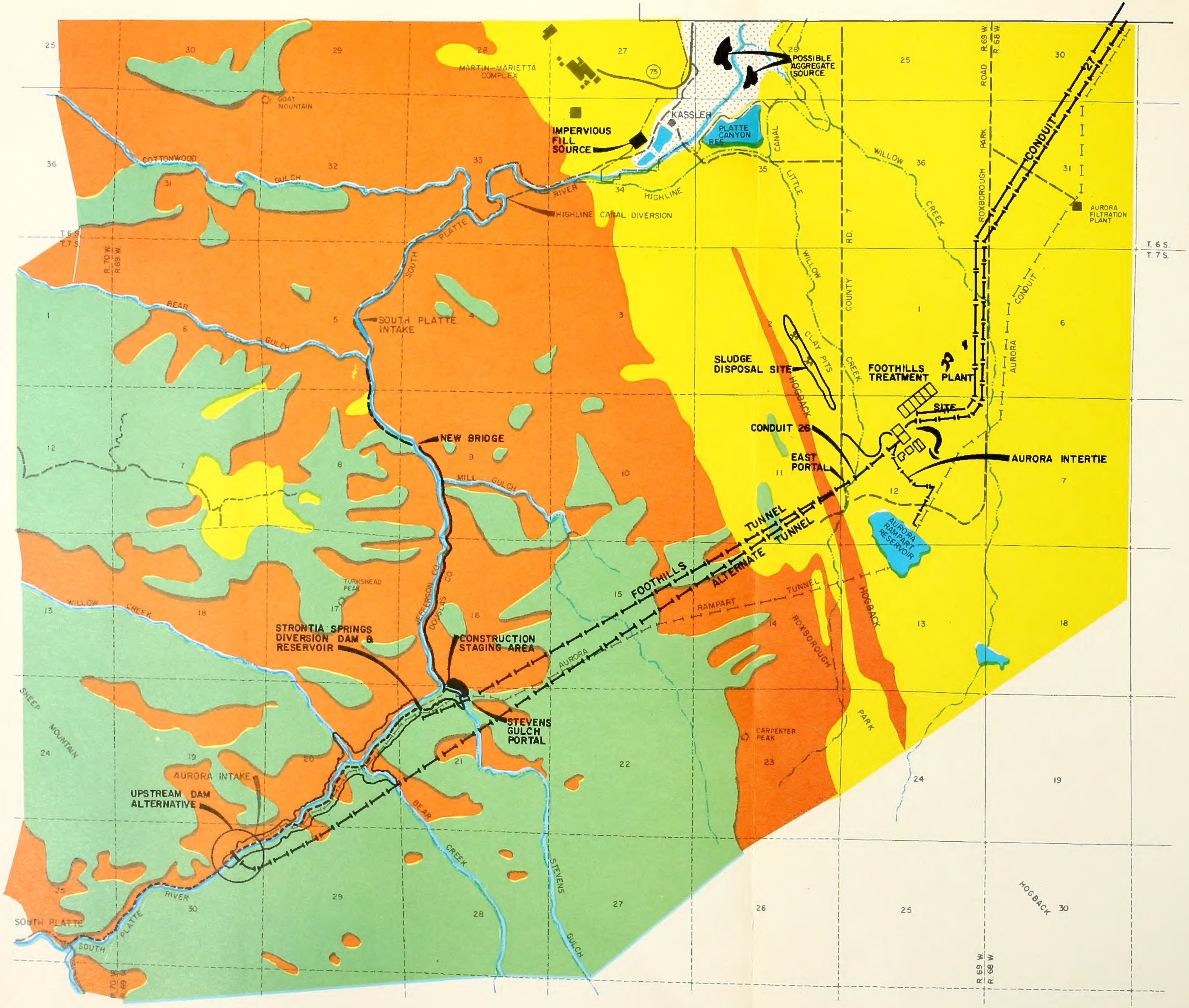
Gambel's oak and mountain mahogany occur throughout the foothills area; however, these shrubs dominate the aspect of south-facing slopes and the lower portion of Waterton Canyon. The shrub-covered hillsides support a sparse stand of mountain juniper and ponderosa pine trees. Douglas-fir, occurring in scattered, tall aggregations in the lower reaches of the canyon, forms a dominant part of the vegetative aspect of the upper canyon (Map 3-9). Dense stands of Douglas-fir also occur in pockets on the north- and northeast-facing slopes, although scattered trees exist throughout the steep-walled Waterton Canyon. Small clearings or openings in the brush and timber support a coverage of grasses and forbs.

To estimate relative amounts of timber, brush, riparian, and grassland vegetation in the Waterton Canyon, acreages of each vegetative type were estimated, using aerial photos and ERT vegetative maps for an area extending 1/2 mile on each side of the river along the eight-mile



DESCRIPTION OF THE ENVIRONMENT

MAP 2-5



TERRESTRIAL RESOURCES

VEGETATION

- BRUSH
- FOREST
- GRASSLAND
- RIPARIAN

N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP – FOOTHILLS

MAP 2-6

between South Platte and the mouth of the canyon (Table 2-26). In the area proposed for the Strontia Springs Reservoir, coniferous timber, primarily Douglas-fir, occupies roughly 35 acres.

Riparian vegetation in the Foothills Project area exists in a narrow strip along each bank of the South Platte River, the North Fork, and side canyons leading into the South Platte Canyon and along Willow Creek, Bear Creek, Stevens Gulch, Mill Gulch, Bear Gulch, and Cottonwood Gulch.

The riparian zone includes various willows, river birch, narrow leaf cottonwood, white fir, Douglas-fir, field horsetail, sweet clover, blue bells, brome and bluegrass. It varies in width but probably averages about 50 feet along each side of the river and about 25 feet in the bottom of the smaller drainages. In Waterton Canyon, riparian vegetation occupies roughly 120 acres or about 2 percent of the area (Table 2-26).

Riparian vegetation occurs to a very minor extent in the grassland area along Willow Creek and Plum Creek. In these areas cottonwood trees and willows are the conspicuous species.

The North Fork of the South Platte River is characterized by two ecological zones - from Bailey to Foxton, lower montane, and above Bailey to Grant, upper montane. The lower montane zone is characterized by Douglas-fir on south-facing slopes and moist areas on those facing north. Limber pine occurs on the ridges and lodgepole pine is common in some areas. Kinnikinick is an important ground cover plant. Aspen is common near the streambank along with some willow.

Wildlife

The following summary of vegetation and wildlife in Waterton Canyon (South Platte Canyon) is taken from data supplied by Ecological Analysts, Inc. at the University of Colorado in Boulder in 1973 (DWB 1974).

> The South Platte Canyon displays rich and varied flora. Based on the current count of over 250 species, it is estimated that the total is close to 270. Vegetation found in the canyon between Stevens Gulch and South Platte represents approximately 1/10 of the species to be found in the entire state of Colorado (Weber, 1972; Smith, 1966; Daubenmire, 1969; Oosting, 1956).
>
> The shrubs and vines along the river comprise several species that are unique to this sort of habitat (e.g., water birch, Jamesia, which is an arctotertiary relic, wild hops, chokecherry, mountain mahogany, Gambel oak). The plant species found in the dam-reservoir area are, for the most part, not rare. However, it is unusual to see these species so abundant. Gambel oak is near its northern limit of distribution in eastern Colorado (Weber, 1972;

TABLE 2-26

RELATIVE PROPORTION OF VEGETATIVE TYPES IN THE WATERTON CANYON

Vegetative Type	Acres 1/	Potential or Actual Vegetation Production 2/ (Pounds per Acre per Year)	Percentage of Sample Area Occupies
Timber	1,600	1,000	31
Brush	3,350	800	66
Riparian	120	1,500	2
Grass (clearings)	50	800	1
Total area	5,120	4,100	100

1/ Calculated from aerial photographs and USGS topographic maps.

2/ Estimated from field reconnaissance.

Harrington, 1964), but is abundant in the canyon. The plants are robust and reproducing well.

Soil condition is important for vegetation growth and ultimately the existence of higher forms of wildlife. The soil and its inhabiting species are interdependent. Animal interactions affect soil formation with droppings, decaying organisms, and plant litter in conjunction with decomposers or decomposer organisms (Taylor, 1935).

Acarina (mites) constitute the major group of organisms found in the soil and are important for their activities, which include digging, channeling, and eating out dead roots (Jacot, 1940). Collembola (springtails) make up another common group in the soil (Ford, 1937). Other animals found in the soil include formicidae (ants), lumbricus (earthworms) and nematodes. These animals, although widespread, appear in less quantity per square meter than do acarina or collembola. Presence of these animal populations indicate productive soils.

A high variance in biomass (total biological material) was found between the different plots of soil that were tested. With the exception of a few plots, soil studies represent "healthy" coniferous biotopes. In a terrestrial environment, the high soil phosphorus content that was found in 12 out of 20 plots tested may be advantageous for the promotion of vegetation growth.

Fifteen species of small mammals were obtained by live trapping in the canyon. This represents a high diversity of small mammals for a xeric (dry) area like the canyon. Two species can be considered rare for the area; the yellow-bellied marmot, which is at the easternmost limit of its distribution, and the prairie vole, which is usually found in wetter habitats than those in the canyon.

Preliminary observations of mammalian faunal distribution and abundance in the Platte River Canyon area, augmented by such historical records as Cary (1911), Warren (1942), and more recently, Lechleitner (1969) and Armstrong (1972), indicate that this ecosystem is one of the richest, in terms of species diversity, in the state of Colorado.

The canyon also contains numerous species of birds. Many breed in the canyon; an additionally large number feed in the area during spring and fall migrations. The diversity of habitats permits a wide range in types of birds, from the stream-feeding dipper to larger raptorial birds.

Willow Creek, Bear Creek and Strontia Springs are some of the more diverse and productive habitats because of the good cover and plentiful food. Warbling vireos, Virginia's warblers, MacGillivray's warblers, western wood peewees, and canyon wrens breed here; bluejays, Townsend's solitaires, solitary vireos, Townsend's warblers, hermit thrushes, and other migrate through the gulch.

The oak thickets are used by the summer resident green-tailed towhees, rufous-sided towhees, Virginia's warblers, yellow warblers, and chipping sparrows. Fall migrants include Wilson's warblers, Townsend's solitaires, and black-headed grosbeaks. The stretch of river to be flooded is used by dippers for feeding and contains several well-protected spots that the dippers have used in the past for nesting. Kingfishers also hunt along this strip of water. Four amphibian ponds exist along the South Platte. One is within the high water line of the proposed reservoir.

The conifer hillsides support birds year-round but especially during the spring and fall migrations. Pygmy nuthatches, mountain chickadees, band-tailed pigeons, and western tanagers are common.

Three species of snakes (prairie rattlesnake, eastern yellow bellied racer, and wandering garter snake) and two species of lizards (red-lipped fence lizard and six-lined racerunner) have been seen in the area proposed for the dam and reservoir. Two amphibians were seen elsewhere in the canyon. This represents over a third of the herpetofaunal species reported from Jefferson and Douglas Counties.

Detailed species lists and available information on species occurrence in the Waterton Canyon and the North Fork of the South Platte River are available on request from the BLM, Denver, Colorado.

As in Waterton Canyon, the North Fork of the South Platte riparian zone contains a rich variety of bird and mammal fauna (BR 1973a). Characteristic mammals are the beaver, mink, water shrew, several species of bats, black bear and mule deer. Beaver depend on the streamside willow and aspen for food and cover and material with which to build their dams. Mink and water shrews are both closely associated with water for food and cover, and mule deer utilize willow and aspen second for browse.

Characteristic floodplain birds are the dipper, broad-tailed hummingbird, western flycatcher, warbling vireo, mallard and blue-winged teal. Dippers are year-around residents of rocky stream bottoms. They utilize rocky areas beside the streams for nesting and feed in the water, often by walking on the bottom.

Dillon Reservoir serves as a resting area for waterfowl during the fall migration season and some nesting may take place during the summer. Data are not available to quantify the above statements.

Raptors probably use the area as hunting grounds, with some nesting taking place near the reservoir. Here again, data is not available to document the extent of use raptors make of Dillon Reservoir.

Map 2-7 depicts the ranges of major species.

Bighorn Sheep

The Bighorn is an important game species inhabiting the project area and has been studied in some detail. A study by Jones and Jones is reproduced in Appendix 1. According to this 1973 report, there were approximately 35 sheep which were year-long residents of the canyon. The herd once numbered about 50 head, but was reduced to 18 during the construction of existing water-system structures. One cause of decimation was thought to be illegal killing by the construction workers, but death from lungworm-induced pneumonia probably occurred also.

The lungworm is transmitted transplacentally and also through the sheep feces via various stages and through tiny land snails which act as an intermediate host. Any factors which would tend to concentrate the sheep would increase the possibility of lungworm infection (Hibler 1972; Parks et al. 1973).

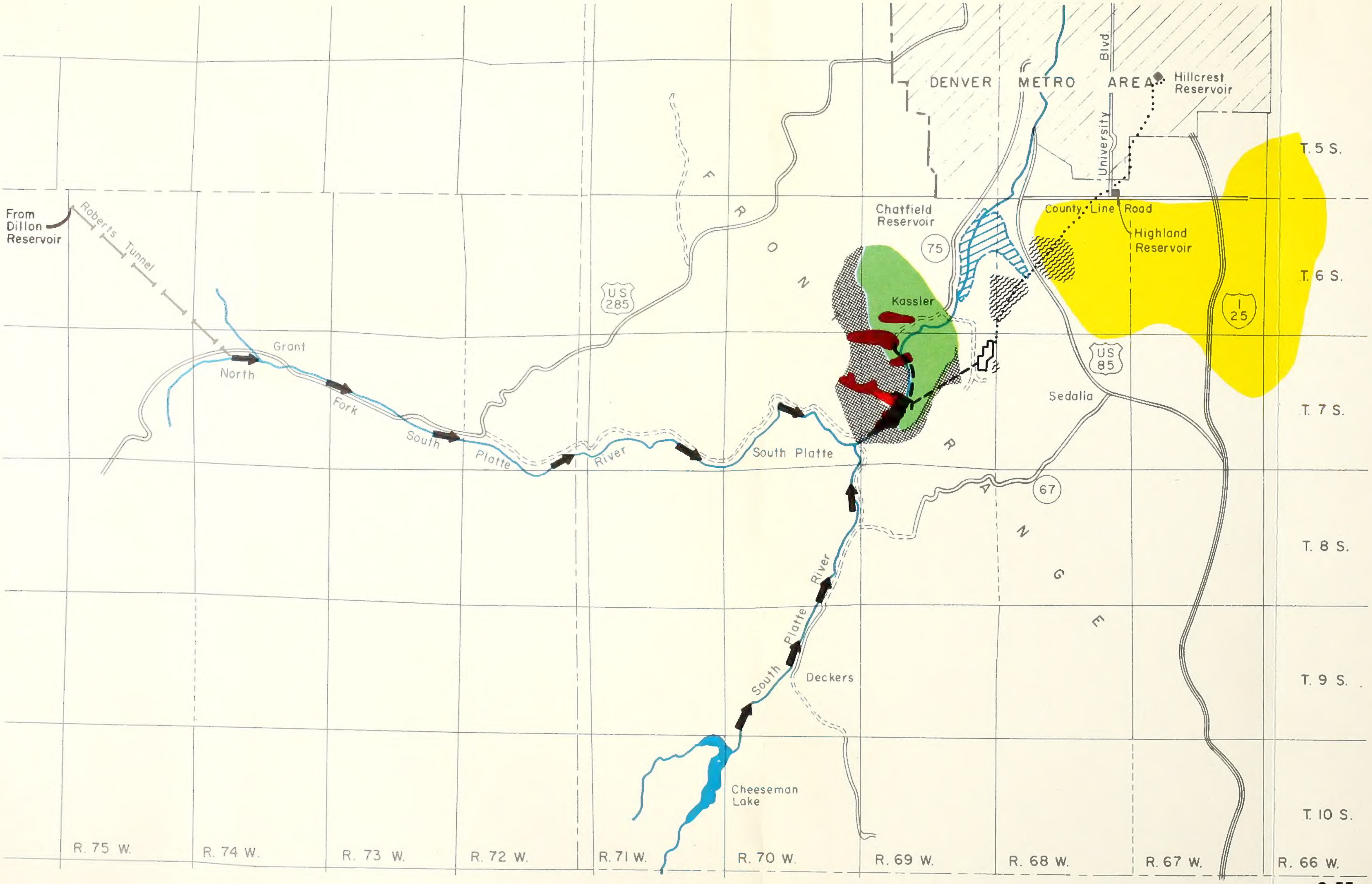
According to the latest information available from members of the Colorado Division of Wildlife (personal communication, Mel dePra, Wildlife Conservation Officer, 1977 and Richard Denney, Big Game Supervisor, 1977), there was a confirmed count of 40 sheep in early March 1977. It is reasonable to estimate the herd at 60 - 65.

Bighorns generally remain on the north side of the river but are occasionally venturing to the south side. They mostly frequent the area of the proposed Strontia Springs Dam and access road. Map 2-7 displays the summer and winter range and the lambing grounds for this herd.

Although the sheep are year-long residents of the South Platte Canyon, during the winter they concentrate in the Waterton Canyon, especially on the south faces between Cottonwood and Bear Gulches. Breeding usually takes place during November and December in these winter concentration areas and lambing occurs in May and June. Water is available most of the year in Willow Creek, Bear Creek, Cottonwood Creek, and at other sites, in addition to the South Platte.

Some of the sheep are accustomed to the presence of humans and are not outwardly frightened by the presence of fishermen and hikers on the road.

TERRESTRIAL RESOURCES



MAJOR WILDLIFE HABITAT

- BIGHORN SHEEP RANGE
- BIGHORN WINTER RANGE
- BIGHORN LAMBING
- YEARLONG ANTELOPE
- PRAIRIE DOGS
- MULEDEER, GOLDEN EAGLES — AREA WIDE

N

0 2 4 6 Miles

DESCRIPTION OF THE ENVIRONMENT

MAP 2-7

In the past four years, the Colorado Division of Wildlife has issued fifteen archery permits to harvest the excess rams from the herd. Of that number, three archers have been successful; two of these three rams were harvested in 1976.

The Colorado Division of Wildlife plans to treat the herd with a drug to reduce lungworm. This stock may then be used as a base herd for transplanting to other areas of the State.

Endangered Species

The peregrine falcon and the Southern bald eagle are the only species classed as endangered by the Federal government that are known to inhabit the project area. However, the northern race of the bald eagle has been proposed for inclusion in the Federal endangered list. There is a remote possibility that black-footed ferrets inhabit the area since there are many colonies of the black-tailed prairie dog in the plains grasslands area. There are two prairie dog colonies along the proposed route of Conduit No. 27 and the second parallel conduit and one colony east of the proposed treatment plant site. However, no documented ferret sightings have been reported in the project area in recent years.

The official list of plant species protected by the Endangered Species Act of 1973 was reviewed. No known threatened plant species occur in the area.

Peregrine Falcon

The peregrine, which is on both the Colorado and national endangered species list, occurs in the proposed project area although there are no known nesting eyries in the South Platte Canyon; however, an active eyrie does exist in the vicinity of the North Fork. In 1972, it was the only successful eyrie of eleven occupied sites in Colorado.

The feeding areas for these birds consist of the riparian areas along the streams and the grasslands along the foothills. These areas provide a food supply consisting of small birds, waterfowl, and shorebirds for the peregrine. The Rocky Mountain-Southwestern Peregrine Falcon Recovery Team has recommended to the U.S. Fish and Wildlife Service (FWS) a portion of the North Fork as critical habitat for this eyrie. The eyrie itself will not be directly impacted by the project, however, the peregrine's hunting areas would be impacted to varying degrees.

Other Animal Species

Golden eagles are common, year-long residents in the area. In addition to the nesting pairs, other wintering eagles frequent the grasslands and riparian zones. Nesting usually occurs in the rocky crags in the canyons, but the birds must have a large feeding radius, which usually encompasses the open plains area to the east. A nesting density of one pair of golden eagles per 36 square miles was reported for similar habitat near Fort Collins (FWS 1964).

Three golden eagle nesting sites have been reported within the project area (Henry 1975). Two of the three known eagle eyries are probably alternate nests of one nesting pair, since they are close together, and only one pair of adults has been seen near the sites. Nesting generally occurs during March and April, and one to two young are usually reared per nesting pair. Nesting eagles are intolerant of human harassment during the early stages of nesting; they will usually abandon the eyrie if repeatedly disturbed (Murphy 1973; Boeker and Ray 1971).

The FWS and Colorado Division of Wildlife are conducting studies to locate and monitor eagle nesting success. They have documented that the nesting population has declined during the last two years. There are apparently surplus nesting sites in the project area for the present nesting population (Craig 1975). The population decline is likely due to low prey populations, especially rabbits.

There is a small herd of about 40 resident mule deer in the canyon. In addition, the area attracts 30 to 40 head of wintering deer. These deer, especially in the winter, use many of the same areas and consume many of the same plants as the Bighorn sheep, but at present population levels no direct competition for space or forage is apparent. Deer use less rocky areas, such as Stevens Gulch, much more than do the Bighorns. Pellet group counts in Stevens Gulch indicate an average of three to five deer days of use per acre per year.

The canyon supports a few mountain lions and black bears on a yearlong basis. Occasionally a few elk, generally fifteen to twenty head, winter along the high open ridges at the upper end of the canyon. Wild turkeys are generally restricted to the higher ponderosa pine and oakbrush slopes and are seldom seen in the canyon.

A small herd of approximately 60 antelope inhabit the area of the proposed Conduit No. 27 and the second parallel conduit. These animals spend a substantial part of their time on the larger ranches where they are not seriously restricted by fences, roads, and untenable human harassment.

The grasslands area supports scattered colonies of black-tailed prairie dogs, which are a major prey species of the endangered black-footed ferret. Two large colonies of several hundred prairie dogs would be bisected by Conduit No. 27, the second parallel conduit, and the access road. These colonies were previously disturbed by the Aurora pipeline, but burrow density is greater now in the soft soil along the line than on surrounding undisturbed land. No evidence of prairie dogs was located on the site of the proposed treatment plant; however, a large prairie dog town was observed to the east of the site. No sign or sighting of black-footed ferrets has been reported in the area.

CLIMATE AND AIR QUALITY

The climatologic and meteorologic environment of the Foothills area is comprised of the Continental Divide on the northwest, the South Platte drainage basin on the south, and West Plum Creek on the east. Five major climatic components are used to describe the baseline conditions for this area: temperature, precipitation, ambient moisture and evaporation, winds, and air pollution. These elements and their interrelationships are briefly described in the following paragraphs; they represent climatologic data collected from fourteen weather stations in the Foothills area (U.S. Department of Commerce 1970a and 1970b).

Temperature

Average temperature at these locations can be correlated with altitude to a large extent; as altitude increases, the average annual temperature decreases. In general, annual average temperatures range from about 45 to 50°F, with extremes of -35 to -40°F during the winter, and close to 100°F during the summer. Extremes of temperature are usually short duration, with fluctuations occurring in any season. At high altitudes, annual averages are in the mid-30s; at lower altitudes they are in the mid-50s.

Precipitation

Precipitation is heaviest during the spring and summer, with May the month of highest average precipitation (2.75 inches). The average yearly precipitation for the project area is about 16 inches. Thunderstorms are prevalent over the plains of eastern Colorado and along the east slopes of the mountains during the spring and summer. On almost 39 days annually, daily precipitation amounts exceed 0.1 inch in the project area; on about 11 days, 0.5 inch is exceeded.

Ambient Moisture and Evaporation

The ambient moisture levels in Colorado are generally low, favoring rapid evaporation and a relatively comfortable feeling even on hot days. The pan evaporation value for the Foothills area is approximately 55 inches per year. New reservoir evaporation for the Foothills area averages about 24 inches per year.

Winds

None of the weather stations in the Foothills area have records of wind data. However, wind speeds and their directions recorded at Stapleton International Airport in Denver indicate the prevailing wind direction is south every month of the year, and the average speed is 9.3 miles per hour. The highest wind speeds occur in March and April and average 10 to 10.5 miles per hour. Winds with the lowest speeds occur in late summer and early fall, with the lowest average monthly wind speed of 8.3 miles per hour recorded for October.

In the rugged mountainous area of much of the Foothills location, local drainage winds can be the predominant feature. Direct measurements have not been made in the South Platte River Basin to document the occurrence of such winds. However, on the basis of measurements made in other areas of the state with similar conditions, it is assumed they do exist. The same types of mountain-valley wind systems can be expected to occur in almost every canyon. Where canyon walls are very steep, relatively little wind is generated. However, where canyon walls are narrow and have gently sloping terrain up canyon, strong flows can occur as air masses move down the valley.

Air Pollution

Although no air quality data are available for the project area, personal observations indicate that air quality standards are not violated except for total suspended particulates. The primary annual particulate standard for Colorado is 75 micrograms per cubic meter, with a maximum of 260 micrograms per cubic meter in a 24-hour period. Personal observation indicates that the suspended particulate standard is exceeded from time to time, as a result of fugitive dust during wind storms.

Presently, only three sources of air pollution exist within the Foothills area: dust from roads, heat from living quarters, and campfire smoke. Dust from dirt roads is the most prevalent source. Cars traveling over dirt roads produce dust that settles slowly and is confined within the valley for a period of time. Smoke from campfires is

generally confined to the valleys. Unlike air over the metropolitan Denver area, which exceeds air quality limitations for carbon monoxide, oxidants, and particulates, air in the project area exceeds only the standard for particulates. This is probably the result of fugitive dust rather than man-caused development.

NOISE

Because of the remote setting of the study area, its noise levels are now low. Ambient levels recorded from all sources at the treatment plant site and in the foothills away from the river were measured in decibels, adjusted (dBA); they ranged from 32 to 40. River turbulence causes the area's ambient levels to rise to 50 or 60 dBA. The Kassler Treatment Plant and occasional traffic along the access road of the canyon, as well as on arterials leading to the study area, are now the primary sound sources in that area (DWB 1974).

VISUAL RESOURCES

Dillon Reservoir is located in a highly scenic part of the Rocky Mountains in Colorado. The reservoir is a dominant feature within an enclosed landscape (one that does not allow panoramic, long distance views). Because recreation use is a major economic factor in this area, the visual sensitivity is high. This indicates that the area is in a visual management class II situtation, which allows a maximum visual contrast of 10 points (as defined in the Visual Resources section of Chapter 3).

The visual corridor of the project area from the Roberts Tunnel to Kassler forms a narrow valley corridor with varying degrees of spatial enclosure (Maps 2-8, 2-9, 2-10 and 2-11). The sense of enclosure is strongest between the Platte Canyon School (1.5 miles east of Shawnee) and Kassler, where lateral viewing distances are often limited to less than 500 feet. The enclosure effect is lessened west of the Platte Canyon School; however, a motorist on U.S. Highway 285 will still find most lateral views limited to one-half mile.

Scenery in this portion of the project area consists of forested and brush-covered foothills with many rock outcrops. Portions of Mount Logan and the Kenosha Mountains (also called the Platte Canyon Mountains) are visible in the middleground from U.S. Highway 285 between Santa Maria and the Platte Canyon School (Figure 2-1). In contrast, Waterton Canyon has extremely steep and rocky sides with comparatively few trees (Figure 2-2).

The North Fork of the South Platte and South Platte Rivers are dominant features within their respective corridors (Figures 2-1 and 2-2). Each, therefore, is a primary factor in the landscape composition in the river portion of the project area.

generally confined to the valleys. Unlike air over the metropolitan Denver area, which exceeds air quality limitations for carbon monoxide, ozone, and particulates, air in the project area exceeds only the standard for particulates. This is probably the result of rural dust rather than man-caused development.

NOISE

Because of the remote setting of the study area, its noise levels are now low. Ambient levels recorded from all sources at the treatment plant site and in the foothills away from the river were measured in decibels, A-weighted (dBA); they ranged from 31 to 40. River turbulence causes the levels [illegible] to range from 40 to 60 dBA. The treatment plant and roads of Waterton, [illegible] Canyon, as well as an appreciable [illegible] in the study area, are now the primary noise sources in the area (DWB 1979).

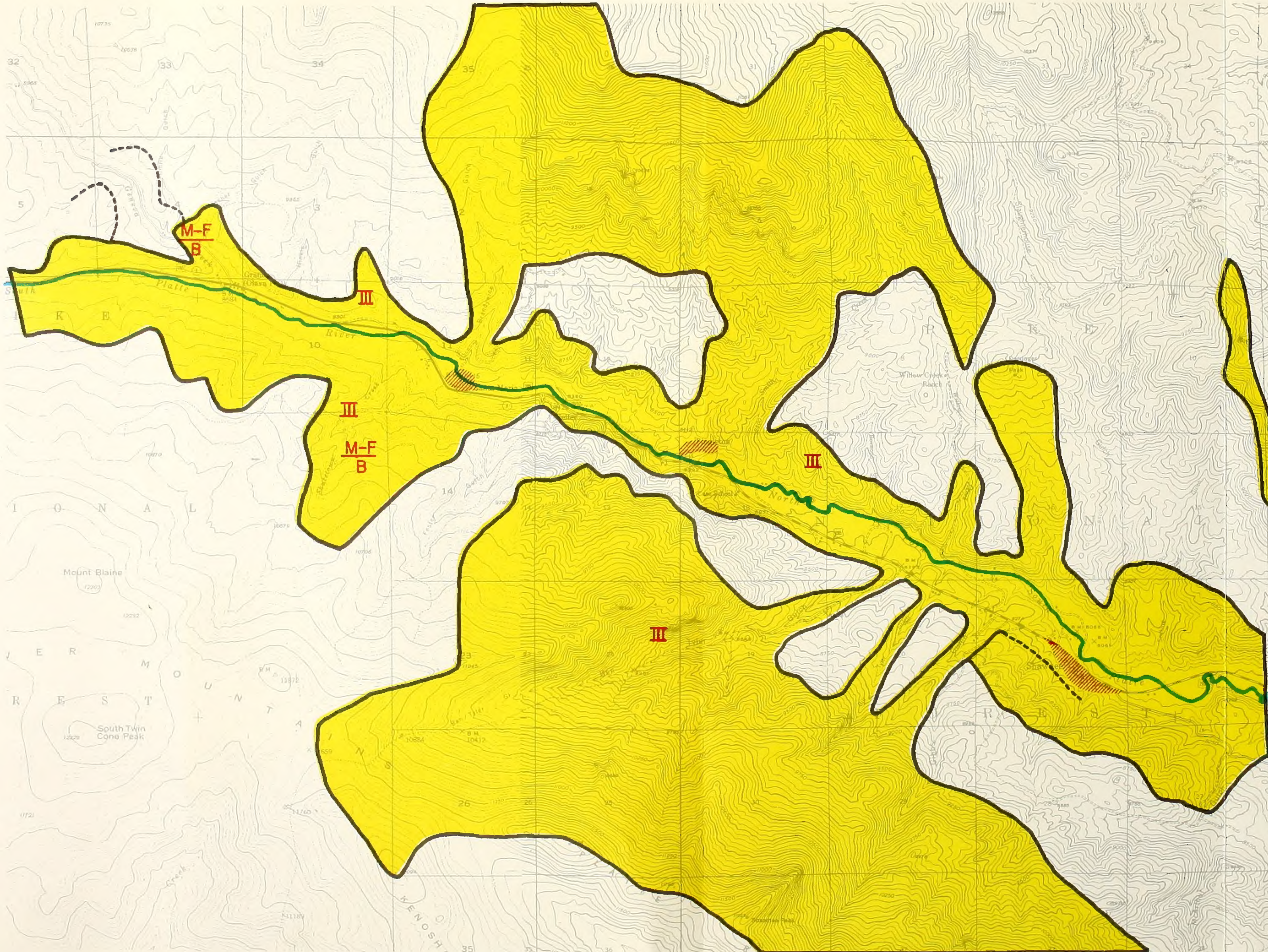
VISUAL RESOURCES

[illegible] is located in a highly scenic part of the [illegible] in Colorado. The [illegible] does not allow generally long distance views [illegible] visual sensitivity is high, [illegible] and 17 illustrations, [illegible] in the Visual Resource [illegible].

The visual openness of the project area from the [illegible] Kassler forms a narrow valley corridor with [illegible] enclosure (Maps 2-8, 2-9, 2-10 and 2-11). The sense of enclosure is strongest between the Platte Canyon (about 11.5 miles east of [illegible]) and [illegible], where lateral viewing distances are often limited to less than 500 feet. The enclosure effect is lessened west of the [illegible] Canyon [illegible]. However, a motorist on U.S. Highway 285 will still find most lateral views [illegible] enclosure [illegible].

Scenery [illegible] of the [illegible] and [illegible] with many [illegible]. The [illegible] Canyon (Figure 2-17). [illegible] Canyon has [illegible] and rocky [illegible] with comparatively [illegible] (Figure 2-18).

The South Fork of the South Platte [illegible] (Figures 2-[illegible]) [illegible] in the [illegible] particularly [illegible].



VISUAL RESOURCES

LEGEND

$\frac{X-X}{X}$ = $\frac{\text{SENSITIVITY - VIEWING DISTANCE}}{\text{SCENIC QUALITY}}$

M MODERATE SENSITIVITY
L LOW SENSITIVITY
F FOREGROUND (VIEWING DISTANCE)
MG MIDDLE GROUND (VIEWING DISTANCE)
B CHARACTERISTIC SCENERY: CLASS B
III VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST

VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE

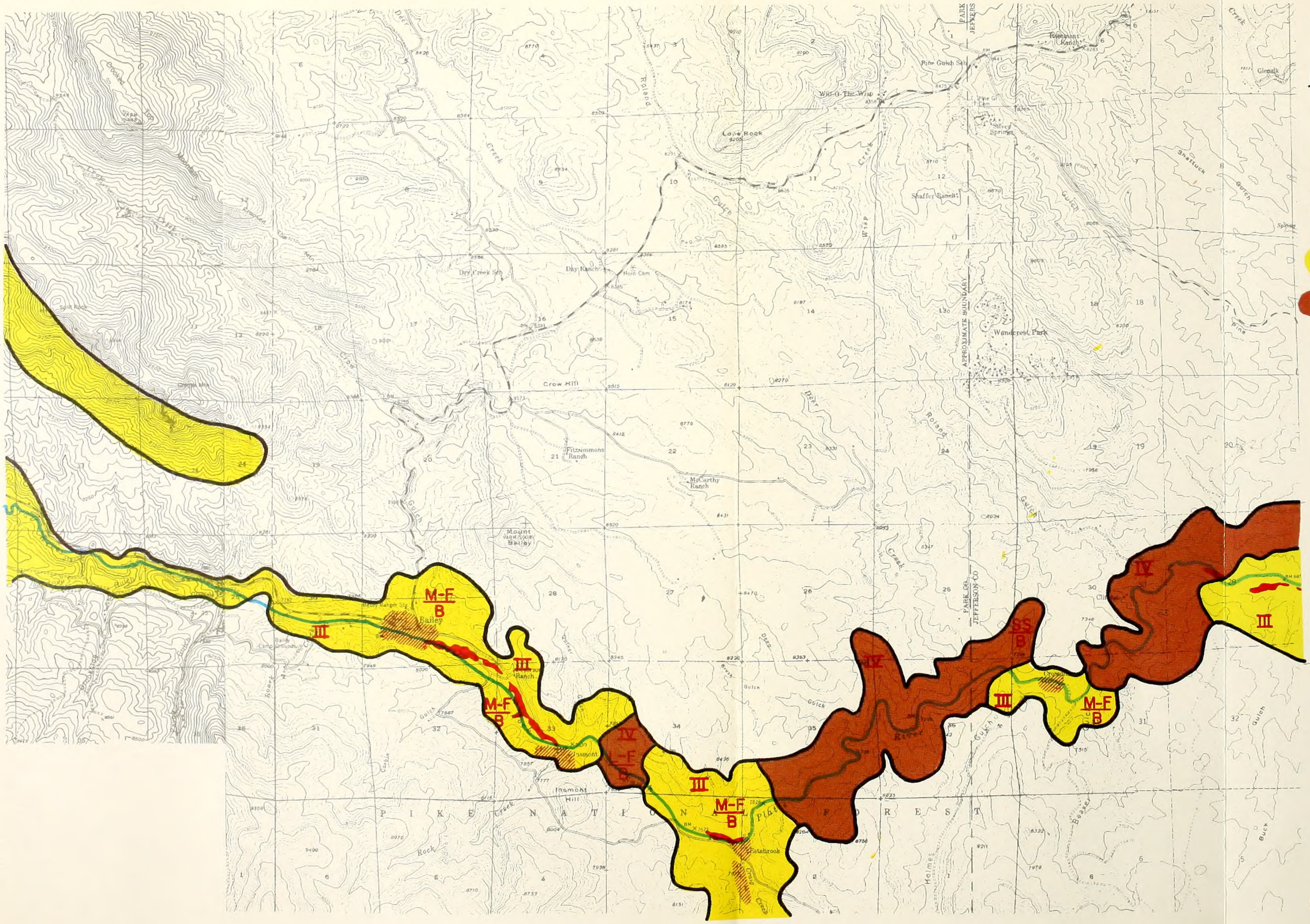
UNSHADED AREAS ARE NOT CLASSIFIED

N

0 2000 4000 6000

DESCRIPTION OF THE ENVIRONMENT

MAP 2-8



VISUAL RESOURCES

LEGEND

$\frac{X\text{-}X}{X}$ = $\frac{\text{SENSITIVITY - VIEWING DISTANCE}}{\text{SCENIC QUALITY}}$

M MODERATE SENSITIVITY
L LOW SENSITIVITY
F FOREGROUND (VIEWING DISTANCE)
MG MIDDLE GROUND (VIEWING DISTANCE)
B CHARACTERISTIC SCENERY: CLASS B
III VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
IV VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST

VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE
FLOODING AREAS AT 1020 c.f.s.

UNSHADED AREAS ARE NOT CLASSIFIED

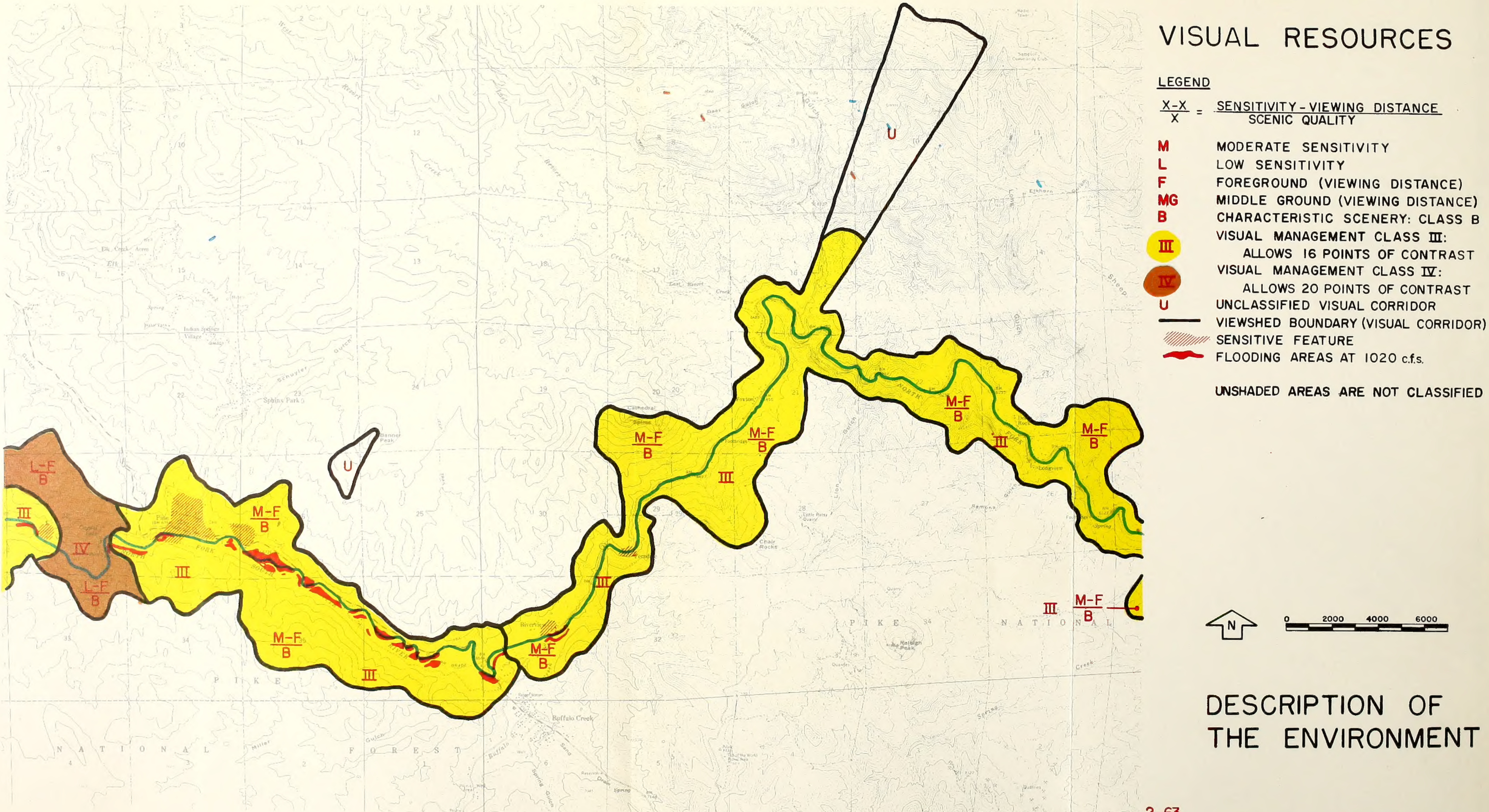
N

0 2000 4000 6000

DESCRIPTION OF THE ENVIRONMENT

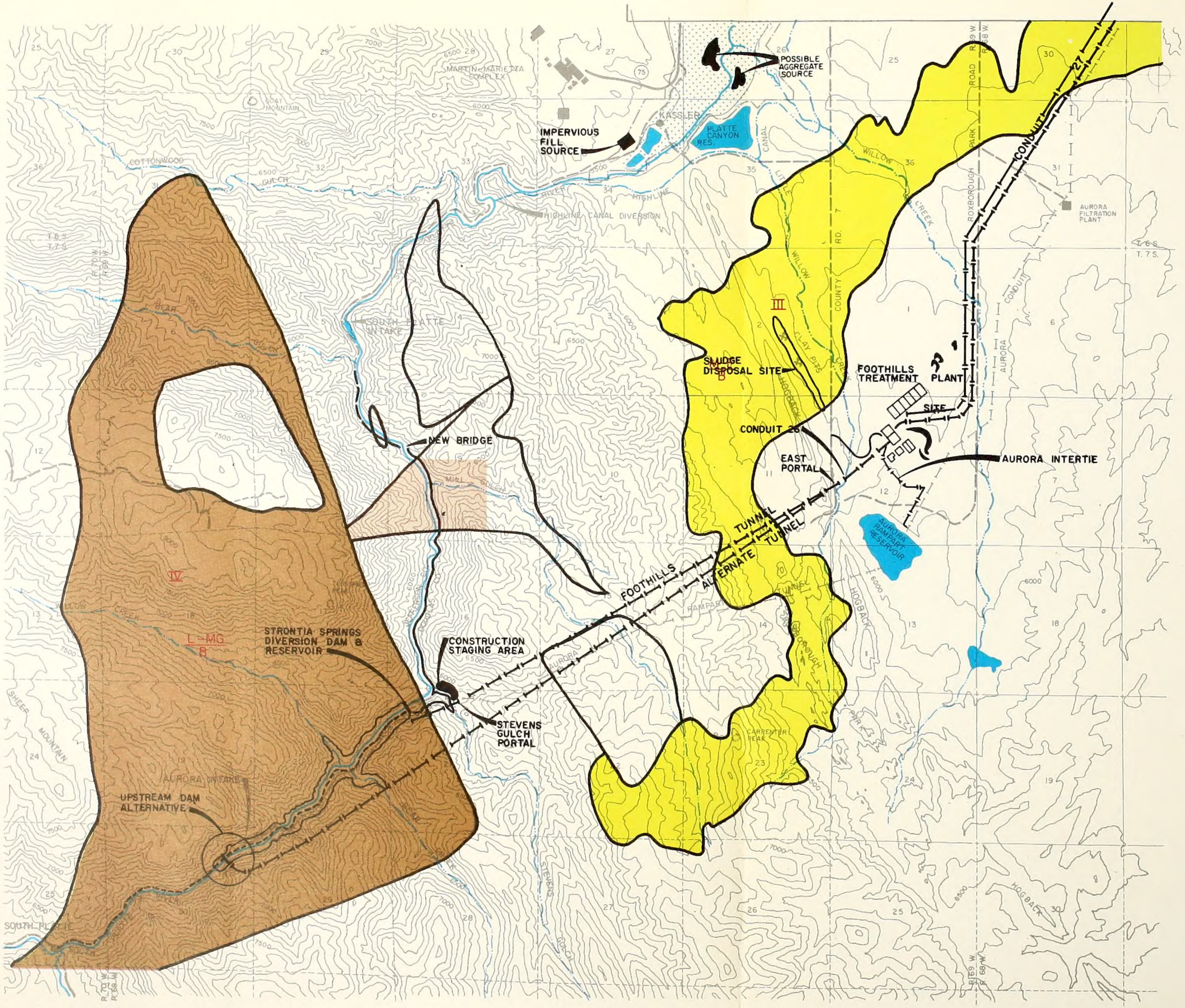
MAP 2-9

VISUAL RESOURCES



DESCRIPTION OF THE ENVIRONMENT

MAP 2-10



VISUAL RESOURCES

LEGEND

X-X / X — SENSITIVITY-VIEWING DISTANCE / SCENIC QUALITY

M — MODERATE SENSITIVITY
L — LOW SENSITIVITY
F — FOREGROUND (VIEWING DISTANCE)
MG — MIDDLE GROUND (VIEWING DISTANCE)
B — CHARACTERISTIC SCENERY: CLASS B
III — VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
IV — VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST

VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE

UNSHADED AREAS ARE NOT CLASSIFIED

N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

MAP—FOOTHILLS

MAP 2-11

Figure 2-1. Scenery associated with the North Fork of the South Platte River.

Figure 2-2. Downstream view of Waterton Canyon below the Keystone Bridge. Note the steep, rocky canyon walls and the strong sense of enclosure found in the bottom of the canyon.

Past and present human use and occupation in this area has resulted in numerous encroachments on the natural landscape. As shown in Figure 2-3, these encroachments include roads, bridges, fences, buildings power lines and other indications of human use and occupation.

Due to the extent of the existing human alterations in this area, it is not considered highly sensitive to change. As shown on Maps 2-8, 2-9, 2-10, and 2-11, most of the river corridor is considered moderately sensitive. A small portion has low sensitivity due to lack of human use or occupation.

The visual management classes shown on Maps 2-8, 2-9, 2-10, and 2-11 are derived by combining the scenic quality of an area and the area's sensitivity to landscape changes. Visual management classes define limits on acceptable contrast levels for changes in the landscape. Contrast is a term used to describe the degree of compatibility between a proposal and the existing landscape. Low contrast values indicate relative compatibility and high contrast values indicate a visually destructive effect.

Although scenery involved in the river portion of the project area is better than average, it is not outstanding for the Rocky Mountains of Colorado. The proximity to the Denver metropolitan area increases the importance of the scenery; however, the present intrusions are significant enough to negate the positive effects of the feature's location.

The proposed water treatment facility, Conduit No. 27, and the second parallel conduit would be located on both irrigated and non-irrigated crop and pasture lands. The land is in a transition zone between the mountains and the plains (Figure 2-4). Although the land is adjacent to the mountains, it strongly displays characteristics of the plains and is generally considered within that physiographic type.

As shown in Figure 2-4, the land involved has flat to gently-rolling topography with grass and some shrubs (e.g., yucca and sage) forming the vegetative cover in non-irrigated situations. The Aurora Rampart Reservoir is the only permanent water body in the immediate vicinity of the proposal; however, it is not visible from the area that the proposed treatment plant and conduit would occupy.

Past and present human use and occupation in this area has also resulted in numerous encroachments on the natural landscape. As shown in Figure 2-4, the immediate site is adjacent to roads, telephone lines, and fences. Denver (with its associated air pollution), power transmission lines and substations, and some industrial development are visible from this site. Due to the extent of the existing human intrusions in this area, it is considered to have a low sensitivity to change.

Figure 2-3. Human encroachments on the scenic integrity of the visual corridor of the North Fork of the South Platte River.

Figure 2-4. View of scenery to the west of the proposed water treatment plant site (foreground). Note the abrupt transition from the plains to the foothills of the Rocky Mountains.

CULTURAL RESOURCES

Archaeological Resources

The proposed project and areas immediately adjacent to it have yielded data representative of almost every prehistoric period known for this section of the Rocky Mountain Province. These include the epi-Pleistocene Agate Basin, Scottsbluff, and Frederick (ca. 8000-5000 B.C.) (Irwin-Williams and Irwin 1966; Scott and Gillio 1975), Early Archaic (5000-3000 B.C.), Middle Archaic (3000-1000 B.C.), Late Archaic (1000 B.C.-A.D. 400), Woodland (A.D. 400-1000), Upper Republican (A.D. 1000-1300), Dismal River (ca. A.D. 1700), Historic Ute (A.D. 1845-1881) (Windmiller and Eddy 1975), and Cheyenne-Arapahoe (ca. 1720-1860) (Olson et al. n.d.).

A portion of the archaeological resources in the proposed project area were documented by a reconnaissance of the impoundment area, treatment plant, and main canyon access (DWB 1974) and augmented by two brief test excavations in the proposed treatment plant area. Further survey and excavations were conducted by Dr. Frank Eddy upstream on the South Platte and the North Fork of the South Platte to roughly its confluence with Buffalo Creek (Windmiller and Eddy 1975). This study resulted in the recording of 79 archaeological and historical sites and 118 loci of isolated artifacts and resulted in concomitant test excavations. Recent surveys by BLM included that portion of the North Fork from its confluence with Buffalo Creek to the Town of Bailey and investigated the staging areas and access not previously recorded.

Survey results did not indicate any evidence of archeological remains in the proposed pool area or along the Waterton Canyon access road. Four sites were located at the proposed treatment plant site and two were subjected to testing. Although both sites exhibited shallow deposition, the "LHS" site produced substantial amounts of cultural debris and a possible hearth. Modest testing of this site, therefore, is not considered adequate for assessment purposes.

Survey and excavation conducted further upstream by Dr. Frank Eddy was completed in anticipation of the proposed Two Forks project and, upon review, none of those data will be affected by currently proposed actions.

Recent investigation between Buffalo Creek and Bailey and in the staging area proved negative. Any site which might have existed between Bailey and the Roberts Tunnel has long been lost due to channelization and domestic and agricultural disturbances.

That portion of the plains to be disturbed as a result of this project may be expected to yield valuable archaeological information

representing a variety of cultures and cultural periods. Data, however, are not available to estimate site density, site types, or site significance in this area.

Historical Resources

As early as 1859 miners seeking gold used the canyon from Bailey to Kenosha Pass as a route to the gold fields of South Park. Such towns as Fairplay, Alma, Buckskin Joe, and others were served by this corridor. However, it was not until 1876 that the canyon was modified into its present condition. In that year, the Denver South Park and Pacific Railroad (DSP&P) (Figure 2-5 and 2-6) began construction of a narrow gage line up the canyon and across South Park. This railroad was highly significant in that it was one of the first mountain rail lines in Colorado, and it was built to serve the timber and mineral bearing region of South Park. Of more importance later on was the fact that it provided rail service to Leadville (via a wagon road over Mosquito and Weston Passes) when the great silver discoveries were made in the upper Arkansas valley.

The DSP&P's key rival was the Denver and Rio Grande Railroad. The Rio Grande, in 1880-1881, attempted to use the South Platte Canyon to build a second line into South Park. However, after construction was begun at South Platte, Colorado and proceeded downstream, the Rio Grande gave up the project, leaving behind several miles of expensive unfinished roadbed. This left the DSP&P the undisputed ruler of the gateway to South Park. Many of the station sites along the DSP&P's mainline became the towns of today. South Platte was founded in 1877 and places like Buffalo Creek and Pine were founded with the arrival of the railroad in the 1870s. Bailey and Grant were founded prior to the DSP&P's coming.

After many years of marginal freight and passenger operations, the DSP&P line was removed in 1938 and the line was scrapped. The existing roadbed from South Platte, Colorado to Buffalo Creek, Colorado was widened and converted into an auto road.

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After many years of marginal freight and passenger operations, the DSP&P line was removed in 1938 and the line was scrapped. The existing roadbed from South Platte, Colorado to Buffalo Creek, Colorado was widened and converted into an auto road.

While the DSP&P was in operation, numerous tourists' facilities developed along the right-of-way. In Waterton Canyon itself, Strontia Springs (Deansbury Station) was developed as a health and tourist spa. Upstream from this spot, little settlements such as Longview, Dome Rock, Foxton, and Buffalo Creek catered to the demands of weekend and summer tourists. As early as 1876 the DSP&P provided transportation into this region and the area was heavily used by Denverites and out-of-towners to spend many hours enjoying the mountain air and scenery of Colorado.

Figure 2-5. The Denver South Park and Pacific Railroad bed and the Keystone Railroad Bridge, Waterton Canyon.

The existing sites along the river and the railbed rockwork are the physical remnants of the development that took place in the 1870s (Figure 2-6).

Figure 2-6. D&RG RR rockwork in the Waterton Canyon.

Upon consultation with the State Historical Society of Colorado, the State Historic Preservation Officer, and the National Register of Historic Places (1976) it has been determined that one site currently on the National Register is within the study area. It is the North Fork of the South Platte Historic District. The Keystone Bridge (Figure 2-5) had been determined eligible for the National Register (1975).

Because the North Fork Historic District includes more land than those areas that will be inundated, a field inventory was conducted in 1974 and 1977 within the entire District (which is under Section 106 protection), and those sites that would be affected by the proposed action were then evaluated. The visual and aesthetic qualities of the District were evaluated pursuant to 36 CFS 800.0 and 800.9, and those sites within the area were recorded. The following sites are either within the North Fork Historic District, in Waterton Canyon, or within areas of possible effect (Table 2-27).

TABLE 2-27

HISTORICAL SITES RECORDED IN 1974 AND 1977 IN THE STUDY AREA

Name of Site	Site Number	Principal Site Feature	Integrity and Condition	Historical Significance: National	Historical Significance: State	Historical Significance: Local	Physical Size	Ownership
Westall Monument	FH-001 1/	Monument	Fair/Fair			X	less than 1 ac	DWB
South Platte, Colo	FH-002 1/	Townsite	Fair/Fair			X	5 acres	various priv.
DSP&P Railbed	FH-003 1/	Railbed	Fair/Poor		X		20 x 150 ft.	Priv./County
Boxcar	FH-004 1/	Boxcar	Fair/Poor			X	less than 1 ac	Private
Foundation	FH-005 1/	Foundation/Wall	Poor/Poor			X	2 acres	DWB
Longview, Colorado	FH-007 1/	Townsite	Fair/Fair			X	5 acres	Private
Dome Rock, Colorado	FH-008 1/	Townsite	Fair/Fair			X	5 acres	Private/DWB
Trail	FH-010 1/	Trail to Foxton	Fair/Fair			X	2.3 acres	Private/USFS
Foxton, Colorado Townsite	FH-011 1/	Townsite	Fair/Fair			X	5 acres	Private
DSP&P Bridge	FH-012 1/	Bridge	Good/Poor			X	100 x 20 ft.	Private
Buffalo Creek, Colorado	FH-013 1/	Townsite	Fair/Fair			X	5 acres	Private
DSP&P Bridge	FH-012 1/	Bridge	Fair/Fair			X	10 x 50 ft.	Private
Glenisle Pavilions	FH-017 1/	Pavilions	Poor/Fair			X	less than 1 ac	Private
DSP&P Rail Grade	FH-014 1/	Railgrade	Fair/Poor		X		10 mi. x 6 ft.	DWB
Deansbury Station	N.A.	Ruins	Poor/Poor			X	5 acres	DWB
Strontia Springs	N.A.	Spring	Fair/Fair			X	1 acre	DWB
Telegraph Poles	N.A.	Telegraph line	Fair/Poor			X	10 mi.	DWB/BLM/USFS
Railway Bridge	N.A.	Bridge	Fair/Fair			X	less than 1 ac	DWB
Keystone Bridge and	N.A.	Bridge	Fair/Fair			X	less than 1 ac	USFS
Denver & Rio Grand Railbed and Rockwork	N.A.	Railgrade	Fair/Fair		X		5 mi. x 10 ft.	DWB/USFS/BLM
DSP&P Bridge at Estabrook	FH-018	Bridge	Good/Good			X	100 x 50 ft.	Private

1/ These sites are currently listed on the National Register of Historic Places and are under the Protection of Section 106 (36 CFR 800.8 and 800.9)

Paleontological Resources

The occurrence of paleontological resources (fossils) which normally are found in sedimentary rocks or very low grade metamorphic rocks would be limited to that portion of the project area east of the foothills. The sedimentary rocks of the great plains are prominent bearers of common marine invertebrate fossils. Extensive lists of fossil localities in the Kassler Quadrangle are available from USGS professional papers (Scott 1963). East of the foothills fossils commonly occur. Two fossil localities have been reported near proposed structures: (1) in the Codell sandstone member (SW 1/4 SW 1/4, Sec. 12, T7S, R69W) and (2) in the shale above Hygiene sandstone member (NW 1/4 SW 1/4 NW 1/4, Sec. 7, T7S, R68W).

On October 5, 1971, during the construction of Chatfield Dam, earthmoving equipment uncovered a mammoth skull some 50 feet below ground, estimated to be 120,000 to 200,000 years old. The rocks directly underlying the Chatfield Dam are significantly younger than those underlying the features of the proposed Foothills Project. Those underlying the proposed features are not reported to contain any fossil mammals. The rocks are of marine nearshore origin and contain only common shellfish fossils (USGS 1963a). However, in the immediate vicinity are located Paleocene deposits of vertebrates (mammals) (Middleton and Gooding 1976) reputed to be the third richest of such deposits known to the scientific community (personal communication, Dr. Peter Robinson 1977).

RECREATION RESOURCES

Waterton Canyon

A combination of natural features in the Waterton Canyon from its entrance to the confluence with the river's North Fork produce above-average recreational opportunities in the front range area. In addition, the proximity of such a steep-walled canyon, with its narrow floor, to the metropolitan area increases the canyon's importance as a recreational resource. The value of this resource is further enhanced by the combination of a rapidly descending, free-flowing river, vegetation of diverse types and patterns, and a wide variety of animal life.

Recreation opportunities in the canyon are varied. Photographers enjoy the varied terrain and abundance of plant and animal life. Particularly attractive is the opportunity to photograph Bighorn sheep, which inhabit the area. The canyon is also used for white-water canoeing and kayaking. Reaches of the canyon were used for Olympic Trials practice in 1972. For purposes of white water canoeing and kayaking the rapids on this stretch of river is rated class 4 and 5 on

a difficulty scale in which class 1 is the least difficult and 6 is the most difficult. History buffs are attracted by the road grade and bridge remnants of the narrow gage railway that was a popular excursion route around the turn of the century. The old roadbed also provides access for fishermen, hikers, and bicyclists. There are opportunities to study geology, plant life, birds, and wildlife in a setting that rates above average for its visual and aesthetic qualities.

The exact number of recreationists visiting the canyon each year is unknown. A field draft report (Bureau of Outdoor Recreation (BOR) 1974a) estimated that 8,000 recreation visits were made to the lower South Platte Canyon in 1973. Based upon Forest Service figures which show a 25 percent increase in recreation use in the South Platte Ranger District since 1973, an estimated 10,000 visits were made to the canyon in 1976.

South Platte River - South Platte to Cheesman Reservoir

With certain important exceptions the upper reaches of the South Platte River and its North Fork are a continuation of the conditions in the lower canyon. The South Platte River, from the forks at the community of South Platte to Cheesman Reservoir, is the most intensively used of all the segments. As shown in Table 2-28, driving for pleasure, floating (canoeing, kayaking, and rafting), fishing, picnicking, and camping are the most popular recreation activities. These activities comprised over 90 percent or 571,600 of the 615,600 total recreation visits to this portion of the river in 1976.

Between the towns of Deckers and South Platte, recreational use is heaviest. User congestion, road dust, erosion, vandalism, littering, and sanitation problems occur as well as competition between recreationists - especially between fishermen and tubers - for the use of the river and adjacent land areas. Nevertheless, this is an important recreation area to residents of the Denver and Colorado Springs metropolitan areas as well as the canyon residents (BOR 1974a).

The stretch of river between Deckers and Cheesman Reservoir provides the best fishing available on the South Platte above the Waterton Canyon area. The road does not follow the river for much of this stretch, so fishermen are required to hike into the river. Because of this, the area is less heavily used than that from Deckers to South Platte.

Cheesman Reservoir, a water-storage facility in the DWB water supply system, occupies a 3-mile segment of the South Platte and is closed to recreational use. Two other DWB reservoirs, Eleven Mile and Antero, lie further upstream. The reservoirs and segments of the South Platte separating them receive substantial recreational use in the form of fishing, camping, and hiking.

TABLE 2-28

INITIAL AND PROJECTED ANNUAL RECREATION USE
SOUTH AND NORTH FORKS (CANYONS) OF THE SOUTH PLATTE RIVER

Activity	Initial (Year 1976) Recreation Day-Use (Thousands) 1/			Projected (Year 2020) Recreation Day-Use (Thousands)		
	N. Fork	S. Fork	Total	N. Fork	S. Fork	Total
Driving (Auto) for Pleasure	137.5	275.0	412.5	235.7	471.5	707.2
Scooter-Motorcycle Driving	6.1	12.3	18.4	10.5	21.0	31.5
Ice-Snow Craft Driving	-	3.6	3.6	1.0	4.9	5.9
Hiking-Walking (foot)	1.3	2.4	3.7	2.7	5.2	7.7
Floating (Canoeing-Rafting)	18.4	36.8	55.2	31.5	63.0	94.5
Fishing	22.6	45.4	68.0	38.8	77.8	116.6
Picknicking and Camping	107.3	214.4	321.7	139.2	278.4	417.6
Recreation Residence	-	6.3	6.3	-0-	10.0	10.0
Hunting (All)	1.3	2.4	3.7	2.0	3.9	5.9
Horseriding	1.9	3.6	5.5	3.2	6.2	9.4
Ski Touring & Snow Play	1.3	2.4	3.7	2.3	4.6	6.9
Other (nature study, gathering forest prod., photography, etc.)	5.6	10.3	15.9	53.9	101.7	161.6
Area Totals	303.1	615.6	918.7	529.8	1,054.2	1,575.0

Source: BR 1973a (figures revised April 1973)

1/ These figures were revised in April 1977.

North Fork of the South Platte River

The North Fork of the South Platte, upstream to the Roberts Tunnel outlet, has several conditions that influence its use as a recreational resource. Most important is the fact that it is used to transport flows from Dillon Reservoir (via the Roberts Tunnel) to Denver. Flow rates as high as 490 cfs are especially common during May, June, July, and August, hindering fishing activities. A hazard to the fisherman, wader, and boater or tuber exists when levels of flow are changed over a short period of time. High-flow requirements have resulted in channelization and bank stabilization between Roberts Tunnel and Bailey, which have altered much of the natural character of the stream. Added to the physical impediments that interfere with recreational use of this stream are the large segments of private land that block public access in several areas. Despite these drawbacks, there were an estimated 303,100 recreation visits along the North Fork of the South Platte River in 1976 (Table 2-28).

Dillon Reservoir, the source of water for Roberts Tunnel, was completed in 1964 and has become one of Colorado's major recreational areas west of the Continental Divide. The most important recreational activities in the area are boating, camping, picnicking, fishing, and skiing, although a breakdown of use data by recreation activity is not available. There were an estimated 358,000 visitor-days (BOR 1974a) of use in the area during 1973; according to U.S. Forest Service determination, a "visitor-day" equals twelve hours of recreational use. Boating facilities consist of a marina at Dillon and four other boat-launching sites around the reservoir. At times, water drawdowns, which average ten feet annually (Tables 2-7 and 2-8), hinder or prevent launching of larger boats (BOR 1974a).

Treatment Plant Site

The proposed tunnel from the Strontia Springs Reservoir would pass beneath a combination of national forest and privately owned land. The most unusual area along this part of the proposed project is the spectacular outcroppings of reddish-brown sandstone conglomerate in Roxborough Park. The tunnel would pass beneath this 3,200-acre land form area just before surfacing at the east portal.

The proposed location for the treatment plant and the conduits, which lies east of the scenic rock formations of Roxborough Park, is characterized by low, rolling, undeveloped grassland. Several roads cross this relatively unbroken landscape, providing opportunities for sightseeing, driving for pleasure, and sighting small mammals and birds. There are no developed recreation facilities nor data available to quantify the degree of recreation use in the area.

The Chatfield-Waterton Canyon-Roxborough area is the location of many non-motorized trails relating directly to the State Trails Program. Chatfield State Recreation Area contains many hiking, horseback, bicycle, and environmental study trails. The Roxborough State Park trails provide for hikers, horseback riders, and handicapped users. The Highline Canal Trail begins at Waterton and extends for 60 miles through metro Denver and Aurora. One trailhead of the proposed Colorado Trail is likely to originate at Chatfield State Recreation Area and extend up through Waterton Canyon.

LAND USE

Land ownerhsip patterns in the project area are dominated by publicly owned land west of the foothills and by non-Federal lands on the plains east of the foothills (Maps 1-2, 1-3, and 1-4). In the Waterton Canyon about one-third of the land is owned by the DWB and the remaining two-thirds is public land. Administrative responsibility for managing Federal lands in and around Waterton Canyon is shared by the U.S. Forest Service (FS) and BLM. Although most of the Federal land in the area is under FS administration, roughly half of the Federal land in the canyon is managed by BLM.

The proposed Srontia Springs damsite and its immediate construction staging area would be on public lands in the Pike National Forest, established by Presidential Proclamation No. 29 of June 23, 1892. The reservoir area above the dam would be on national forest land, on DWB land, and on public lands administered by BLM. The access road, power line, and telephone line proposed within Waterton Canyon upstream from the Waterton Canyon intake dam would be on both BLM-administered land and national forest land.

The Kassler-Waterton segment of the South Platte River as well as the South Platte-Grant segment of the North Fork has been of interest for water storage or power development for more than 70 years. All of the public lands, both BLM and national forest, affected by the proposed dam and access road and power and telephone lines have been reserved for power purposes since 1909 by the Federal Power Commission, or for water storage since 1943 by the Bureau of Reclamation's proposed South Platte Project (Map 1-2).

Of the 35-mile segment of the North Fork of the South Platte upstream from South Platte to the east portal of the Roberts Tunnel, less than 5 miles, nearly all of it in the Estabrook-Cliffdale area, pass through national forest land in the Pike National Forest.

The rough foothill area lying between the South Platte Canyon and the plains is predominantly national forest land while land east of the foothills is, for the most part, privately owned. Ownerships range from private individuals to corporations and from municipalities to State government.

The public lands are administered for multiple use purposes. Although each tract of Federal land is incapable of sustaining all uses, some of the following uses may be supported: recreation, grazing, wildlife habitat, watershed, mineral production, forestry, and specialized uses such as rights-of-way for dams, tunnels, power lines, and roads.

The Foothills Project area lies on the southern edge of the expanding Denver metropolitan area. Land uses existing in the project area include urban, light industrial, grazing, farming, woodland, and extensive recreational use. Maps 2-12, 2-13 and 2-14 show the general area and extent of existing land uses in the vicinity of the project.

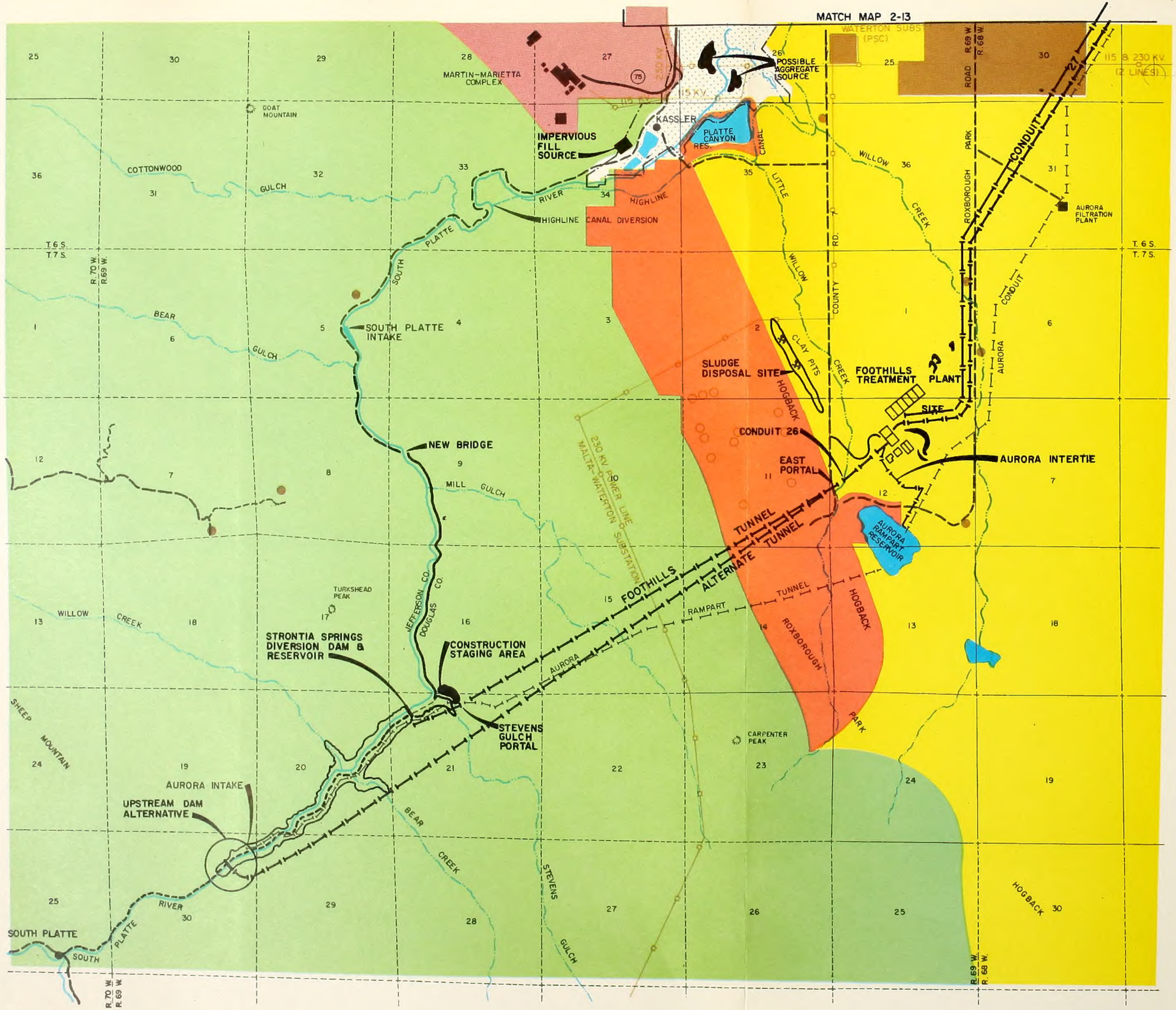
Land uses in the 35-mile segment of the North Fork upstream from South Platte consist of many small communities that developed from early agricultural settlement and from summer cabin sites, fishing and related recreational use that developed along the now-abandoned DSP&P Railroad that provided early and fairly easy access to and through the area from Denver. These uses - recreation and agriculture (meadow hay and livestock production) - continue as the principal economic activities. Fairly good roads exist into and through the area.

The DWB has done some stream channel modification along the Grant-Bailey segment of the North Fork of the South Platte River and purchased flood-flow easements to accommodate infrequent future times when DWB service-area needs will require passage through the Roberts Tunnel of its entire 1,020 cubic feet per second capacity.

Land uses in Waterton Canyon, limited by the rough rocky terrain, are mostly confined to the narrow canyon bottom. Recreation use and water diversion facilities (dams, conduits, tunnels, roads and power lines) operated by the DWB and the City of Aurora form the most conspicuous uses of the canyon.

A DWB caretaker's house at the South Platte Intake Dam is the only residence in the canyon. None of the land is used for livestock grazing, and forest or woodland products or mineral materials such as sand and gravel are not being taken from lands in the vicinity.

The topography along the route of the proposed tunnel has precluded conversion of the present woodland or open space to more intensive land uses. The City of Aurora's Rampart Tunnel No. 2 passes under the area. The Public Service Company's (PSC) 230-kilovolt electric transmission line from the Malta substation near Leadville, Colorado, to the PSC Waterton substation crosses northwesterly about midpoint of the proposed tunnel route.



LAND USE

GENERAL LAND USE

- RANGELAND
- DRY FARMLAND
- FOREST & WOODLAND
- UNDEVELOPED AREAS, OPEN SPACE
- LIGHT INDUSTRIAL, COMMERCIAL
- INDIVIDUAL DWELLINGS OR FARMSTEADS IN THE VICINITY OF THE PROJECT.
- RESIDENCES OR CONDOMINIUMS IN SOME STAGE OF CONSTRUCTION AS PART OF ROXBOROUGH PARK PLANNED COMMUNITY DEVELOPMENT.
- MAJOR POWER TRANSMISSION LINES
- CHATFIELD RESERVOIR AREA

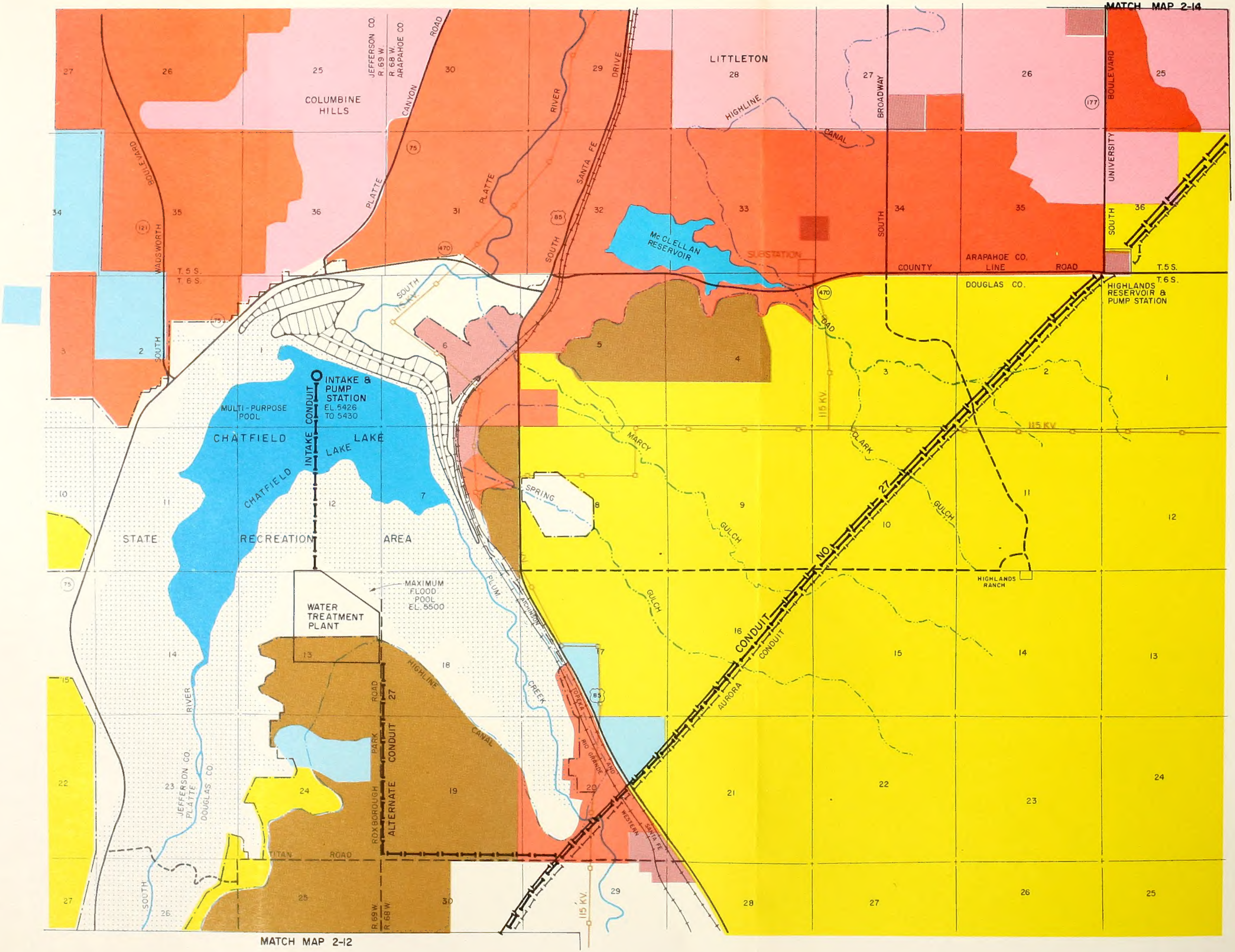
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-12



LAND USE

GENERAL LAND USE

- RANGELAND
- DRY FARMLAND
- UNDEVELOPED AREAS, OPEN SPACE
- LIGHT INDUSTRIAL, COMMERCIAL
- LOW DENSITY RESIDENTIAL DEVELOPMENT
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- CHATFIELD RESERVOIR AREA
- MAJOR POWER TRANSMISSION LINES

N

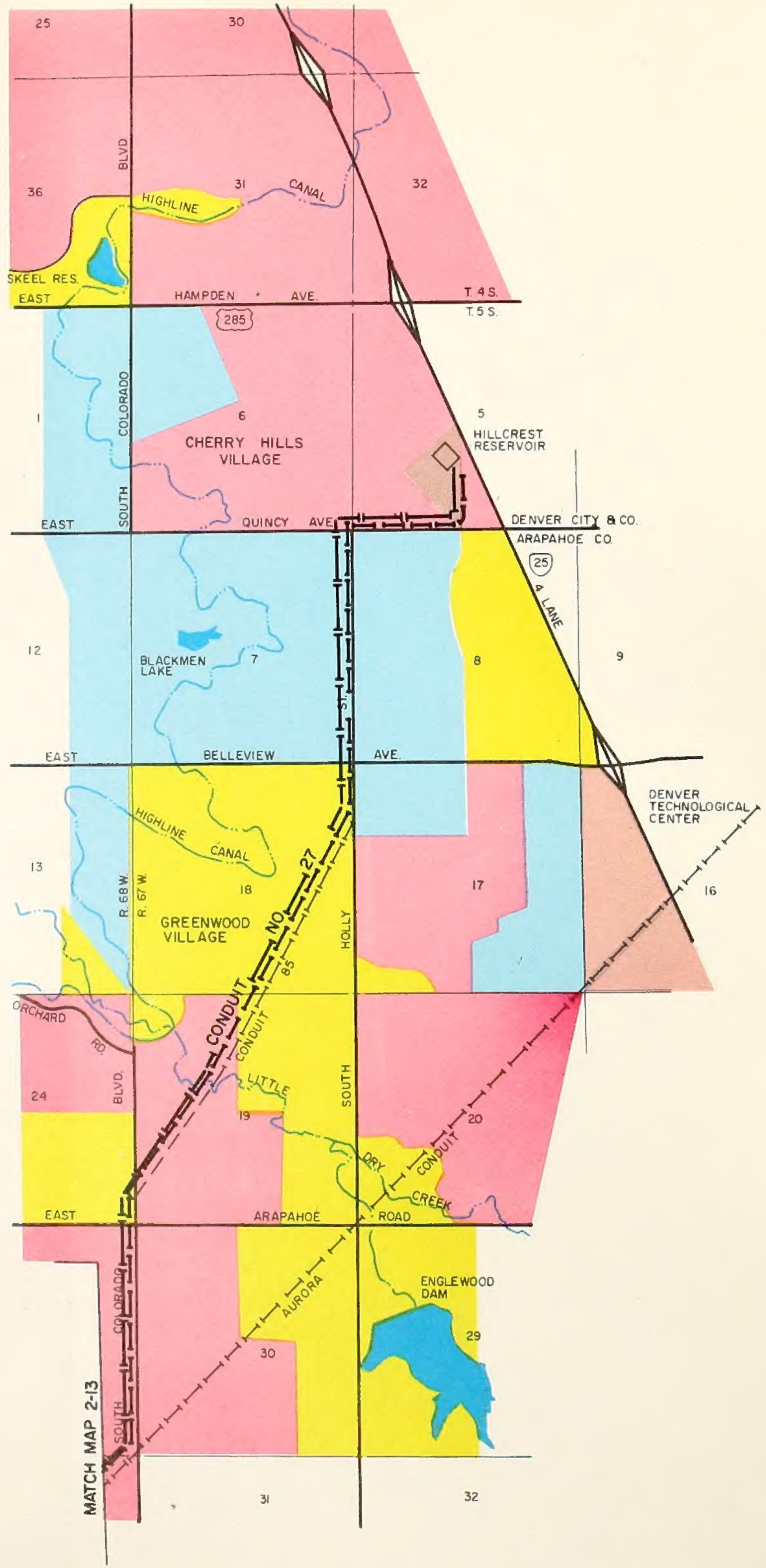
0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

2-79

MAP 2-13



LAND USE

GENERAL LAND USE

- UNDEVELOPED AREAS, OPEN SPACE
- LIGHT INDUSTRIAL, COMMERCIAL
- LOW DENSITY RESIDENTIAL DEVELOPMENT
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT

N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - HILLCREST RESERVOIR

2-80

MAP 2-14

Roxborough Park, under which the eastern one-fourth of the tunnel would pass, is a planned community development of rural residential homesites and condominiums. About 50 individual homes or condominiums have been started; however, most have not been finished because of bankruptcy proceedings involving the entire acreage. Presently, there are eight families residing in the development, although it is designed for about 20,000 residents.

The high plains in the vicinity of the east portal of the proposed tunnel, Conduit No. 26, the water treatment plant, Conduit No. 27, and the second parallel conduit have been in non-Federal ownership for 75 to 100 years. The lands in this area are in single (presently agricultural) ownership that range in size from 80 to 1,000 acres. Many of them in the vicinity of the treatment plant site are in a speculative transition to rural subdivisions. The Highlands Ranch, lying along the route of the proposed Conduit No. 27 and the second parallel conduit, is a large, single-ownership grazing area of more than 20,000 acres.

These lands have retained their rural pastoral character and are used principally for livestock grazing. There are occasional small patches of sub-irrigated meadowland or fields that are dry-farmed for small grains. Light industrial and commercial developments occur at the intersection of U.S. Highway 85 and Titan Road and nearby at Louviers. Such land uses are not common in the area.

Between Highlands and Hillcrest Reservoirs the land use pattern changes from open space-grazing to urban developments. The urban areas along the southern edge of the metropolitan area are relatively new and are separated by considerable undeveloped acreages. Within 1 mile of the proposed conduit in this area there are approximately 5,880 developable acres, of which 2,970 are presently developed. The urban development presently extends to about one mile north of County Line Road between Arapahoe and Douglas Counties. A variety of land uses occur in this area, including grazing, farming, developed residential neighborhoods, streets, and developing subdivisions. Along the conduit most of the farming is for wheat or other small grains.

BLM approved a right-of-way in 1966 for the City of Aurora to construct a diversion dam and reservoir of about 0.8 acres on the South Platte River about 1 1/2 miles upstream from the proposed Strontia Springs Dam. A FS special use permit is also involved with the City of Aurora. A 5-foot diversion pipeline buried in the roadbed extends east along the river to the Strontia Springs damsite where it feeds into Rampart Tunnel No. 1. An underground conduit in Stevens Gulch connects Tunnel No. 1 with Rampart Tunnel No. 2, which brings water to Aurora's Rampart Reservoir near the DWB's proposed treatment plant.

The City of Aurora's large diameter aqueduct from Aurora-Rampart Reservoir to Aurora crosses the high plains area along roughly the same alignment proposed for Conduit No. 27, past Highlands Reservoir to East Dry Creek Road and South Colorado Boulevard, where the two routes would separate.

Seven miles north of the site of the proposed treatment plant, the Corps of Engineers' Chatfield Dam was completed in 1975. It is a flood control dam on the South Platte River and Plum Creek, which will be maintained as a core for a public recreational area now being developed under the administration of the Colorado Division of Parks and Outdoor Recreation.

Although the project area is relatively undeveloped, land use zoning regulations for Douglas County dated January 23, 1974, control and will continue to control the types of land use allowed in the area. These regulations support a county-wide comprehensive land use plan that allows for: (1) new communities and villages with residential densities up to 2 1/2 dwellings per acre, including the Roxborough Park subdivision and an area extending west and south of the proposed treatment plant, and (2) agricultural subdivisions with a residential density up to one dwelling per ten acres, including the treatment plant site and extensive areas to the north, east, and south. Except for the rough foothills area (which is comparable to Douglas County's zoning for rough foothills area) Jefferson County zoning affords more intensive urban and suburban uses. Arapahoe County's suburban character is reflected in more restrictive zoning than the other counties, principally for residential use.

The transportation system shown in Maps 1-2, 1-3, and 1-4 provides relatively easy access to most of the area affected by the project. Access in the South Platte Canyon is limited to the canyon bottom by locked gates. Locked gates on DWB property at Kassler and South Platte limit automobile travel into and through the canyon to DWB employees or contractors, City of Aurora, BLM, FS, and other Federal, State, and local government personnel with responsibilities in the area. The area is open to the general public for nonmotorized recreation use. The road in the South Platte River Canyon from Kassler to the South Platte intake (3 miles) is a two-lane graveled road built on the abandoned narrow gage railroad bed that once occupied the canyon. From the intake dam upstream to South Platte, a distance of 6 miles, there is a single-lane unsurfaced road with infrequent turnouts. An existing single-lane unsurfaced road provides vehicles access from the Kassler-South Platte road through Stevens Gulch for 1/2 mile to the above ground conduit connecting Aurora's Rampart Tunnels No. 1 and 2.

Access to the proposed facilities east of the foothills is provided by Douglas County Road No. 7, which is gravel-surfaced from Colorado State Highways 75 and 470 at Kassler to the Roxborough Park Area. The unsurfaced Roxborough Park road provides public access via Titan Road

from U.S. Highway 85 to the site of the proposed treatment plant and east tunnel portal. In the rolling plains between Roxborough Park and the Denver metropolitan area, access is generally limited to existing roads, although the gentle terrain does not preclude cross-country travel.

Although much of the country along the alignment of proposed Conduit No. 27 and the second parallel conduit is undeveloped, the Roxborough Park road, Aurora filtration plant road, Titan Road, U.S. Highway 85, and the Highlands Ranch road provide access to the alignment at roughly 1 1/2 mile intervals between the proposed treatment plant site and Highlands Reservoir. At Highlands Reservoir, paved County Line Road links transportation from U.S. Highway 85 to city streets extending southward from the Denver metropolitan area. These public roads and streets provide access to or along the proposed conduit alignment between Highlands and Hillcrest Reservoirs. The preliminary annual average daily traffic volumes for 1975 are shown in Table 2-29 (Colorado Division of Highways Traffic Investigations Section).

Other transportation modes in the area include two railroads which parallel U.S. Highway 85 - the Denver and Rio Grande Western and the Atchison, Topeka and Santa Fe. Both have commercial siding tracks at Louviers.

Stapleton International Airport, 25 miles northeast of the project area, is the nearest large-scale commercial air service. Arapahoe County Airport, 9 miles east of the project area, accommodates local non-commercial service. A short landing strip near Louviers, in Douglas County, handles small, local aircraft use.

FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

INTRODUCTION

The Description of the Future Environment without the proposed Foothills Project is based on several important assumptions derived largely from historical data and trends, which follow.

1. The total amount of raw water reliably available to the DWB from its collection, storage, and diversion systems will remain at 312,300 acre-feet annually. No additional raw water will become available.

2. Human population in the DWB service area will continue to grow as estimated by the Denver Regional Council of Governments (DRCOG). The advisory group for the Foothills Project for socio-economic

TABLE 2-29

ANNUAL AVERAGE DAILY TRAFFIC VOLUME (1975 PRELIMINARY) AT CONDUIT NO. 27 CROSSINGS OF OR WITHIN RIGHT-OF-WAY FOR EXISTING ROADS

Road	Daily Traffic Volume
Titan Road	1,400
U.S. Highway 85	4,800
County Line Road	3,900
South Colorado Blvd. between East Dry Creek Road and Arapahoe Road	6,300
Crossing Arapahoe Road	16,100
South Colorado Blvd. between Arapahoe Road and East Orchard Road	4,100
South Holly Street between East Orchard Road and East Belleview Ave.	4,100
Crossing East Belleview Ave.	10,000
South Holly Street between East Belleview Ave. and East Quincy Ave. No data available for traffic volume on East Quincy Ave.	2,850
Colorado Highway 75 between Wadsworth Blvd. and Platte Canyon Road	7,150
Wadsworth Blvd. just north of Highway 75	4,150
Highway 75 between Wadsworth Blvd. and Kassler	7,900

Source: Colorado Division of Highways, Traffic Investigations Section, unpublished.

discussion including representatives of the Colorado Division of Planning, HUD, EPA, BR, BLM, and DRCOG chose to use population projections of DRCOG (Table 1-4).

3. As long as raw water is available the current trends in water use patterns will continue. This will be indicative of commerical, industrial, fire protection, governmental user, and operating losses needs that will accompany the projected growth in population. Such trends will be reflected in both the average per capita per day consumption and in the maximum-day per capita consumption.

4. All discussion in this section will be directed to conditions in the year 2001.

The future environment as described is based upon the conditions that are predicted to occur in the foreseeable future. The predictions in turn are based largely on projected population growth for the DWB service area as shown in Table 1-4.

SOCIO-ECONOMIC IMPLICATIONS

The DWB's capability to treat raw water would be limited to a rate of 520 mgd. In order to insure that the DWB system treatment and transmission capacity is not overtaxed, water-use restrictions beginning early in spring and continuing through fall would be implemented. These restrictions would become more severe with each succeeding year, as the population continues to increase.

Review of Table 1-4 indicates that DWB's present reliable annual raw water supply (312,300 acre-feet) would become inadequate to meet annual demand between 1985 and 1990. If no additional treatment capacity is developed and water-use restrictions are implemented, the reliable annual raw water supply would be fully utilized in 1990. This is indicated by the data presented in Table 2-30. Before 1990, the DWB's ability to deliver treated water during peak-use periods of the year would be limited by available treatment capacity. Beginning in 1990, the DWB's ability to provide treated water would be limited both by treatment capacity and available raw water.

Since water shortages would be inevitable in view of current levels of use during peak-use periods, the greatest restriction that could be imposed would be to limit per capita use to winter months' rates. At the current average winter-use rate (117 gallons per day per capita), the projected reliable annual water supply available for treated water service in the year 2001 (291,356 acre-feet) would serve a population of about 2,200,000.

use of stored water) from South Platte Reservoirs. Average annual flows in the DWB system would continue to increase until about 1990, when the amount of reliable raw water presently available to the system would be fully utilized. Without additional raw water supplies, average annual flows would not increase after 1990. Projected average annual flows at a number of locations in the South Platte River watershed are shown in Table 2-31.

Table 2-32 presents the projected monthly average discharge without the Foothills Project at several locations within the South Platte River watershed including Roberts Tunnel imports. These flows are based on a number of assumptions.

1. Full utilization of the South Platte and Roberts Tunnel Systems reliable water supply is superimposed upon the average streamflow and diversions as reflected by the ten-year period, 1964-73.

2. Average monthly streamflow of the South Platte River at Waterton is representative of the flow anticipated after full use of the reliable water supply from the South Platte and Roberts Tunnel Systems in the event of the recurrence of a similar ten-year period.

3. Diversions in the reach of the South Platte River between South Platte and Waterton for purposes other than water treatment would remain the same as the average for 1964-73.

298,000 acre-feet	- South Platte River at South Platte
-148,400	- South Platte River at Waterton
149,600	
-117,700	- DWB - South Platte River and Roberts Tunnel Water Treated (DWB 1964-73)
31,900	- Historical Diversion

4. Moffat Treatment Plant would operate for a six-month period, April through September.

5. These discharge values are not absolute due to vagaries of climatic, hydrologic, and demand conditions from year to year.

Channel stabilization work completed in the upper 12.8-mile reach of the North Fork South Platte River can accommodate sustained flows up to 680 cfs. Projected average monthly discharges on the North Fork South Platte River at Grant without the proposed action are within that level.

TABLE 2-31

PROJECTED AVERAGE ANNUAL FLOW AT KEY GAGING STATIONS
WITHOUT THE FOOTHILLS PROJECT

Gaging Station	Historical 10-year Average Flow (1964-1973)		Projected Discharge 1990	
	cfs	ac-ft	cfs	ac-ft
South Platte River below Cheesman Dam	177	128,200	177	128,200
North Fork of the South Platte River below Grant 1/	68	49,400	-	-
North Fork of the South Platte River at South Platte 1/	157	113,900	-	-
Roberts Tunnel Imports	41	29,600	156	112,900
North Fork of the South Platte below Grant with Roberts Tunnel	109	79,000	224	162,300
North Fork of the South Platte at South Platte With Roberts Tunnel 2/	198	143,500	307	222,600
South Platte River at South Platte with Roberts Tunnel 2/	412	298,000	521	377,100
South Platte River below Denver 3/	649	469,500	711	514,600

1/ Flows of the North Fork of the South Platte River at Grant and at South Platte not including historical Roberts Tunnel diversions.

2/ Flows reflect assessed losses of 5 percent on Roberts Tunnel diversions.

3/ Includes the sum of South Platte River at 19th St. gage plus estimated sewage return (57% of additional Roberts Tunnel import) and recorded discharge of Clear Creek at mouth.

4/ 2001 projected flows would be the same, assuming no raw water increase.

TABLE 2-32

PROJECTED MONTHLY AVERAGE DISCHARGE OF THE NORTH FORK SOUTH PLATTE RIVER AT GRANT AND SOUTH PLATTE, AND SOUTH PLATTE RIVER AT SOUTH PLATTE WITHOUT THE FOOTHILLS PROJECT
(INCLUDING ROBERTS TUNNEL IMPORTS) (in cfs)

Month	Roberts Tunnel Imports		North Fork South Platte River at Grant		North Fork South Platte River at South Platte		South Platte River at South Platte	
	Historic 1/ Discharge	1990 2/ Projected Discharge	Historic 1/ Discharge	1990 Projected Discharge	Historic 1/ Discharge	1990 Projected 3/ Discharge	Historic 1/ Discharge	1990 Projected 3/ Discharge
January	22	152	30	169	67	191	134	158
February	17	148	32	163	58	182	123	247
March	20	145	38	163	69	188	149	268
April	37	189	63	215	127	272	332	477
May	26	179	148	301	375	520	900	1045
June	14	30	255	271	490	505	910	925
July	74	90	230	246	362	377	762	777
August	141	199	226	284	348	403	664	719
September	66	218	113	265	182	326	377	521
October	27	208	65	246	123	295	238	410
November	19	159	48	188	93	226	184	317
December	24	152	46	174	73	195	143	265
Average Annual	41	156	109	224	198	307	412	521
Acre-feet	29,600	112,900	79,000	162,300	143,500	222,600	298,000	377,100

1/ Historic discharges are ten year (10) averages for the period 1964-1973.
2/ Based on population projections and historical use patterns, the 112,900 acre-feet raw water available in Dillon Reservoir would be in use by 1990.
3/ The future imports have been reduced by 5% loss at South Platte stations.

As additional waters are diverted from Dillon Reservoir through the Roberts Tunnel, the annual drawdown of the reservoir will increase until the annual dependable raw water supply is fully utilized.

AQUATIC RESOURCES

The aquatic environment of the North Fork of the South Platte River will be greatly changed in the foreseeable future. There would be a 60 percent reduction in the fish population and a 95 percent reduction in bottom fauna.

The Dillon Reservoir fish population will be concentrated into a smaller area. This in turn will result in the larger, more predatory fish utilizing the smaller fish. The net result will be fewer but larger fish in the reservoir. Brown trout will be the main benefactor of this phenomenon. There would be fewer invertebrates and reptiles hibernating in the expanded mudflats. There would also be less aquatic vegetation in the reservoir.

GEOLOGY, MINERALS AND TOPOGRAPHY

The future environment probably would not differ significantly from the present environment. The processes of erosion, weathering, and deposition will continue to make minor modifications of the existing geologic formations and topography; however, in one lifetime most of these modifications would go unnoticed.

It is possible, from existing data, that economic mineral deposits could be found or developed along the South Platte Canyon in the future. This conclusion is largely based on a USGS report (1963b) which indicates that metallic and nonmetallic minerals have not been found in minable quantities in the South Platte Canyon, but that, based on geologic inference, deposits of uranium or pegmatite minerals may well be present in minable quantities awaiting discovery.

SOILS

Rates of soil development, soil erosion, and soil deposition are expected to continue as they are at present. Much of the natural productive

potential of the soils would be lost when urban expansion takes place on much of the flat area. The soils in the canyon and along the riparian zones of the South Platte would be subject to accelerated erosion, as a result of increased flows and increased recreation use.

TERRESTRIAL RESOURCES

In the future, the terrestrial ecosystems in Waterton Canyon and the North Fork of the South Platte would be subjected to increasing pressures from recreation visitors. Visitor use and attendant problems are expected to compound, leading to greater harassment of wildlife. The Bighorn sheep population in the canyon would probably decrease or move out of these areas. If they remain in the canyon, the herd would probably be managed for 76 head. Other forms of big game would probably decrease in numbers and species diversity. The eagles and the peregrine falcons observed in the area would probably seek a more secluded place to nest.

The increased flows in the North Fork of the South Platte River and the South Platte would probably cause unquantifiable temporary destruction of riparian vegetation along sections of the rivers that have not been channelized; however, at some future time the riparian zone would re-establish along the high-water line. Until this would occur, habitat would be lost for all forms of wildlife.

Continued subdivision, road construction, and water appropriation on surrounding private land is certain. Species such as raptors and big game animals, which are wide-ranging and not able to exist solely in the canyon, would probably continue to decrease in total numbers and species diversity.

The grasslands ecosystem would probably continue to decline in diversity from excessive livestock grazing, subdividing, road construction, and expanded human encroachment.

The value of the Waterton Canyon as a relatively undisturbed area would increase greatly as habitat conditions decline in the surrounding area due to increased people pressure.

CLIMATE AND AIR QUALITY

Although climate is not expected to change, air quality in the project area would probably be reduced as the result of the encroaching urban area. However, air quality in the Denver area could be improved also

if the Air Quality Maintenance Plan (EPA 1974) is successful. By 1981, carbon monoxide emissions would be reduced to an allowable level for human health, and by 1988, total vehicular emissions of hydrocarbons would be reduced to limits allowable for human environments (EPA 1974).

Present emissions of nitrogen oxide are well within acceptable limits. Barring the introduction of currently unscheduled major uncontrolled sources, no violation of the nitrogen dioxide standard would be indicated in the future (EPA 1974).

NOISE

Without the proposed project the noise levels in the project area could be expected to remain about the same.

VISUAL RESOURCES

Increased recreation use, more channelization of the North Fork of the South Platte River and additional private developments along the North Fork and in the area of the proposed treatment plant would gradually reduce the scenic quality and visual integrity of the project area.

CULTURAL RESOURCES

Considering trends in projected population growth and urban expansion, points of cultural value in the project area can be roughly projected as follows.

1. Archaeological resources would experience considerable abuse through uncontrolled surface collecting and digging, activities that are going on in the area at the present time. Urban expansion toward the treatment plant site would probably destroy many archaeological sites.

2. The railroad grades (including associated cuts and rock work) would undergo further alteration and deterioration through use, access road upkeep, and the effects of weather; however, they should not be drastically changed.

3. The Deansbury Station and Strontia Springs sites should remain in about the same condition they are today, unless they are flooded or vandalized.

4. Without the project, paleontological potential would remain the same.

RECREATION RESOURCES

In the future, as the Denver metropolitan area expands toward the south along the front range, the resultant population would generate increasing demands for a variety of recreational opportunities. Recreational resources such as Waterton Canyon, the South Platte River above South Platte, and the North Fork of the South Platte River would be subjected to increasing recreational demands.

For example, the estimated 10,000 annual visits that occurred in the Waterton Canyon in 1976 would increase at least in proportion to population increases and probably at greater rates, until restrictions are placed on visitor use.

Conversely, under a properly developed and enforced recreation program, the environment of the canyon could likely remain a high-quality resource. The nearly natural qualities and abundant recreational opportunities which are provided by this area would become increasingly unusual and desirable as the metropolitan area grows. The potential would remain for reconstructing the narrow gage railroad for tourism use.

Recreation use pressure would also increase on the South Platte between Cheesman Reservoir and South Platte and along the North Fork. As shown in Table 2-28 the use in these areas is expected to approximately double by the year 2020. Most of this area is within the South Platte Planning Unit of the Pike-San Isabel National Forest. The unit's land management plan is currently scheduled for completion in 1980. Prior to completion of the management plan, the Forest Service would provide the facilities necessary for resource protection and management of recreation use.

Between 1980 and 2000, the Forest Service could be expected to expand recreational opportunities to an optimum level which would consider additional development sites as well as providing for dispersed recreation.

High flows resulting from diversions of water from Dillon Reservoir through Roberts Tunnel will continue to limit the recreation opportunities on the North Fork of the South Platte. Channelization efforts will continue downstream from Bailey to handle these flows. Large water flow

volumes and rapid flow increases will continue to be hazardous to river users, especially fishermen and boaters.

Drawdown of Dillon Reservoir would increase as population in the DWB service area grows.

Roxborough Park, a proposed 756-acre State park now in the acquisition stage, will be established to accommodate recreational needs of the expanding population. This unique area, featuring reddish-brown sandstone conglomerate outcrops and spires, will be primarily for daytime outdoor recreation, i.e., nature study and trails for walking and horseback riding. Other activities will include sightseeing, photography, and picnicking. The park will also include an interpretative center, picnic sites, and parking lots. The area will handle about 1,000 visitors per day. Trails leading into the national forest to the west from Roxborough Park could provide a nonmotorized access route into Waterton Canyon.

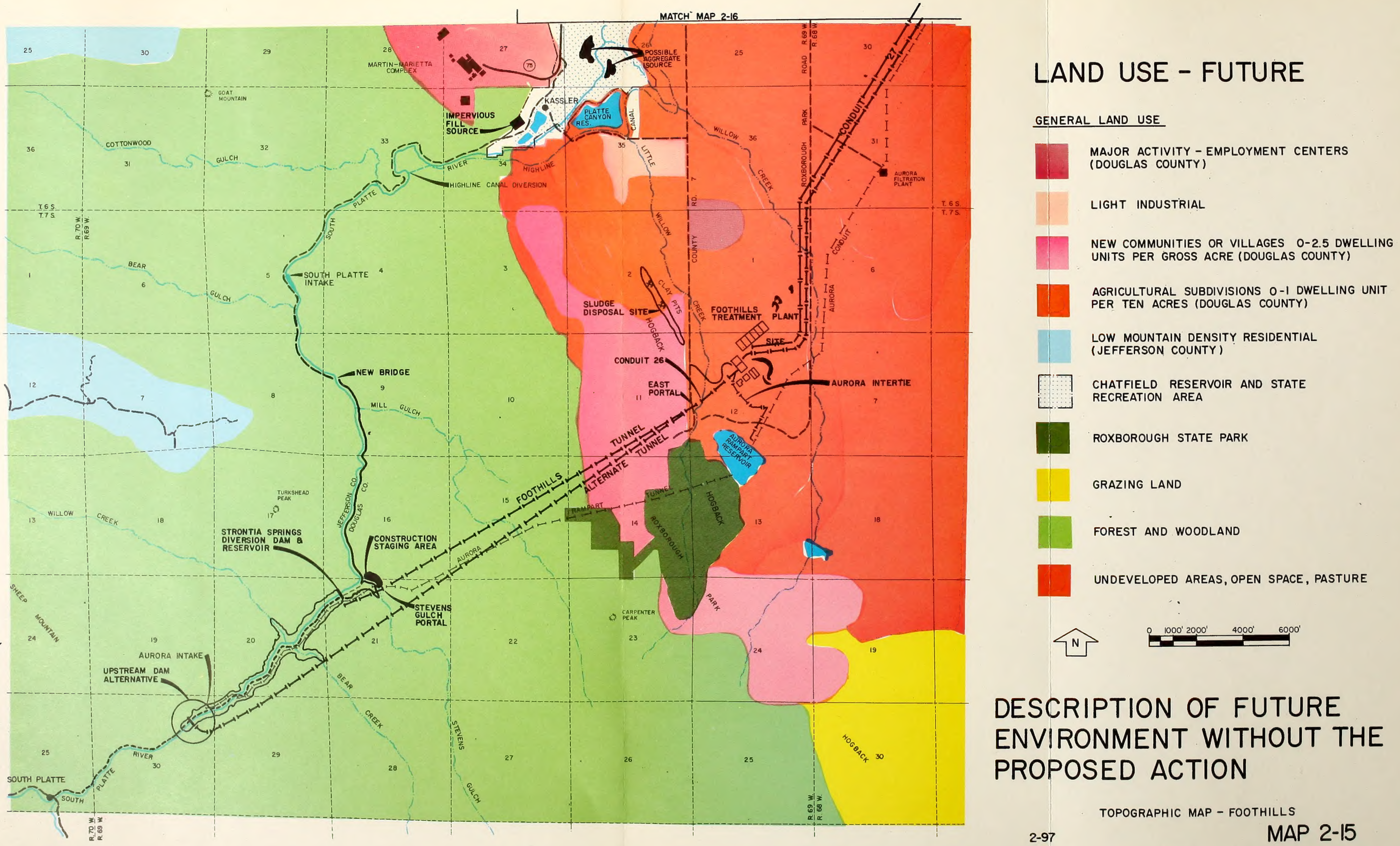
Chatfield Dam will retain a permanent recreation pool that covers about 1,300 surface acres. Recreational facilities which are being planned and developed by the Corps of Engineers will be managed by the Colorado Division of Parks and Recreation to provide recreation opportunities that will help meet the needs of the growing metropolitan area. Activities such as boating, fishing, picnicking, overnight camping, and hiking will be accommodated adjacent to an area where considerable growth is anticipated.

LAND USE

Maps 2-15, 2-16 and 2-17 show anticipated future land ownership and land use without the proposed project. Presence or absence of the project features does not play a large part in future land ownership. Future land use patterns will probably be established by topographic features, such as the very rough Waterton Canyon, man-made features such as the large Chatfield Dam and Reservoir, and land use trends, comprehensive land use plans, zoning, transportation, and utilities. The land ownership and land uses along the North Fork of the South Platte would continue about as at present. Some increase in summer homesite development is probable.

Lands in Waterton Canyon and along the tunnel route would remain publicly owned, except that their management would likely be by only one Federal agency. It is probable that some of the private lands within the present USFS boundaries would be returned to Federal ownership through exchange.

Large acreage single ownerships in the vicinity of the treatment plants site would become agricultural subdivisions. It is likely that the DWB would retain the land it presently owns at the east portal and



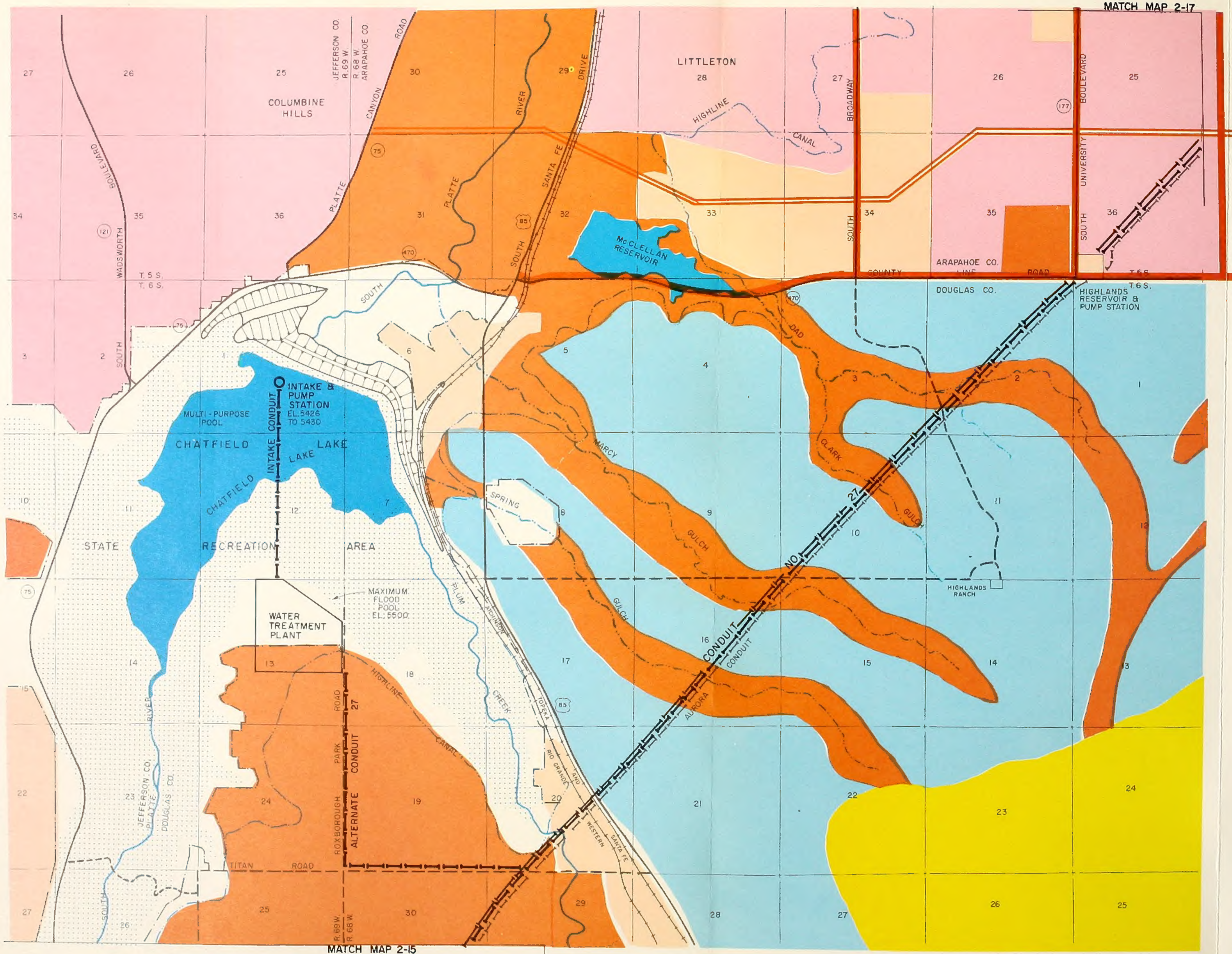
DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-15

MATCH MAP 2-17

LAND USE - FUTURE



MATCH MAP 2-15

GENERAL LAND USE

- LIGHT INDUSTRIAL
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- AGRICULTURAL SUBDIVISIONS 0-1 DWELLING UNITS PER ACRE
- AGRICULTURAL SUBDIVISIONS 0-1 DWELLING UNITS PER 10 ACRES
- RANGELAND
- UNDEVELOPED AREAS, OPEN SPACE, PASTURE
- PARKWAY
- MAJOR ARTERIAL ROADWAYS
- CHATFIELD RESERVOIR AND STATE RECREATION AREA

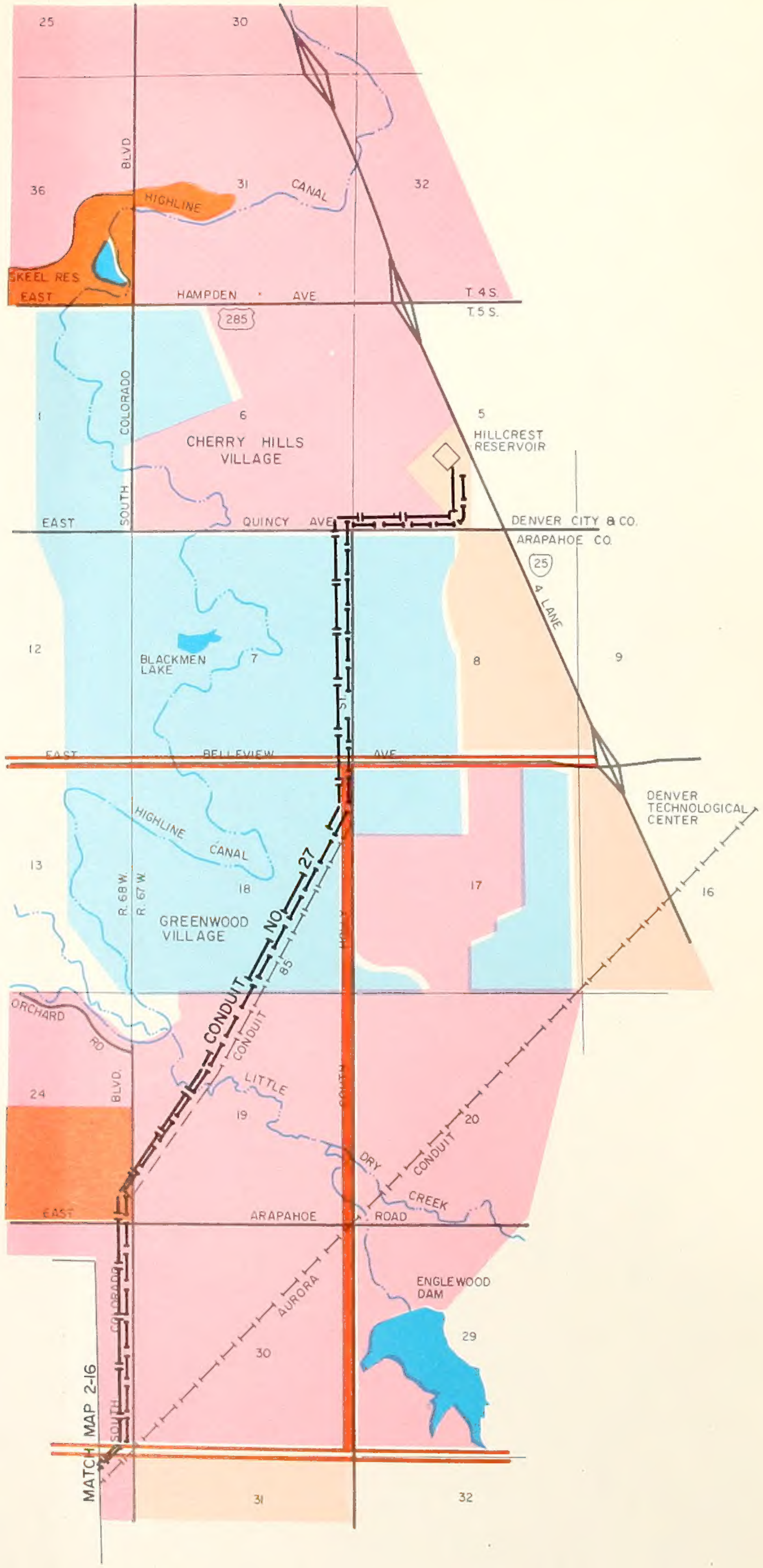
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

MAP 2-16



LAND USE - FUTURE

GENERAL LAND USE

- LIGHT INDUSTRIAL, COMMERCIAL
- LOW DENSITY RESIDENTIAL DEVELOPMENT
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- OPEN SPACE
- MAJOR ARTERIAL ROADWAYS
- PARKWAYS

N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - HILLCREST RESERVOIR

MAP 2-17

at the treatment plant site, and the right-of-way for Conduit No. 27 and the second parallel conduit. The City of Aurora would retain its diversion, tunnel, reservoir, and linear easement for its aqueduct. Private ownership of lands along the route of Conduit No. 27 and the second parallel conduit would continue, but would change from the present large acreage single ownerships to many small acreage units and intensive residential development.

The rough topography along the tunnel route would preclude conversion of the land to more intensive uses; however, increased recreational use could be expected with development of adjacent Roxborough State Park, Chatfield Lake State Park, and full development of the presently platted Roxborough Park Planned Development Community. Present zoning and comprehensive land use plans accommodate some commercial and light industrial use in the general area of the treatment plant site; such uses could be expected to develop.

In the vicinity of the treatment plant site, small acreage residential units would supplant present rangeland use. Along most of the route of Conduit No. 27 and the second conduit parallel to it in Douglas County through present agricultural, rangeland, and open space areas, land use change to light or moderate density could be expected. Interspersed open space would occur where drainages or other land features precluded intensive development. Commercial and light industrial use would also occur on a limited basis.

An additional large diameter water conduit would probably be installed within Aurora's present aqueduct easement from Rampart Reservoir. Figure 2-8 displays an existing and future linear area of non-development similar to the future along Aurora's right-of-way. Circumstances are more favorable for moderate density residential development along the route on Conduit No. 27 and the second parallel conduit within Arapahoe County. Most of the present agricultural, pasture, and open areas would be developed for moderate density residential use, with some areas changing to commercial, office, and light industrial use.

Full development of the Roxborough subdivision and Roxborough State Park, and changes to agricultural subdivisions would result in improved roads into the area of the treatment plant site. Utilities would be upgraded. Land use changes from rangeland to residential, commercial, and light industrial along the route of Conduit No. 27 and the second parallel conduit would stimulate upgrading of existing roads and utilities, and construction of many new ones.

It is probable that urban growth would continue in the future at a rate about equal to that experienced in the past; that is, areal urban development of 73 acres annually within 1 mile of Conduit No. 27 and the second parallel conduit, and a linear growth rate of about 0.1 miles annually from north to south. At this rate it is probable that the southern limit of development would be County Line Road in 2001. At this

point it is probable that linear growth would slow, but areal growth would continue. Development in Douglas County would probably depend on a large-scale concept with self-contained support features. This may cause a delay in that growth; however, overall the present rate would probably continue south and west. Growth would probably extend along the proposed conduit to Highway 85 in 2001 and to the Roxborough Park Road at the north edge of the proposed treatment plant complex by 2055 - the end of the life of the proposed project.

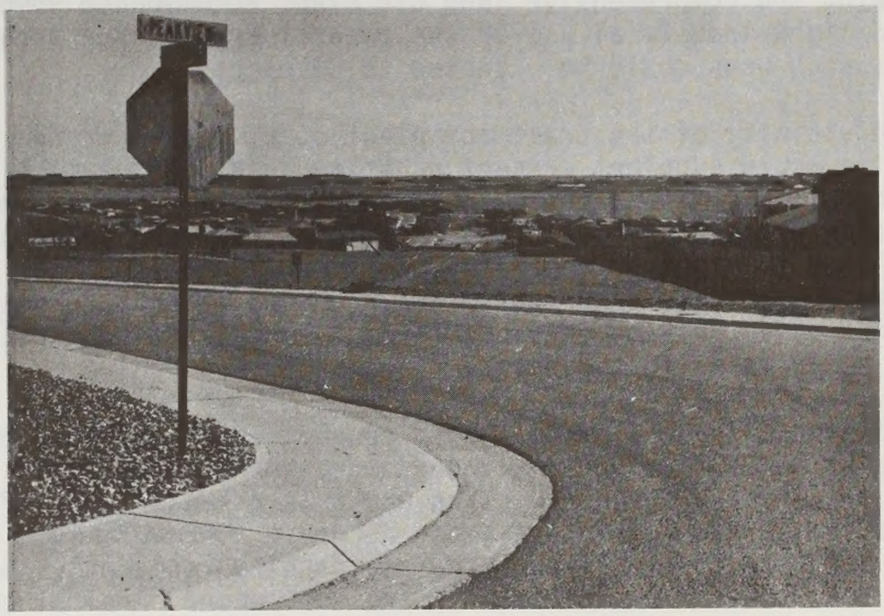


Figure 2-7. The right-of-way for DWB's Conduit No. 85 creates a linear area of non-development where it passes through a developing subdivision.

SUMMARY OF FEATURES OF EXISTING AND FUTURE ENVIRONMENT

Following is Table 2-33, which summarizes the features of the existing and future environment described in Chapter 2.

TABLE 2-33

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Socio-Economic Conditions	1. Human populations: 1,402,500 (1975) (DRCOG)	1. Human populations: 1,693,700 (2010) (DRCOG estimate)
	2. Employment and Manpower: 6.5% unemployment (3/1977); 725,600 labor force (3/1977).	2. Industry is #3 on priority list of water (after 1. domestic, 2. agricultural); industries dependent on DWB for daily service would layoff in water shortage periods.
	3. Housing: 563,837 dwelling units (4/1976).	3.
	4. Municipal and Industrial Water Systems:	4. Municipal and Industrial Water Systems: current use trends would continue as long as raw water is available; supply will remain 312,300 ac-ft annually.
	a. DWB treated water capacity 520 mgd (1977).	a. Treated water to DWB's service area would be limited to maximum day rate of 520 mgd; without additional raw water, supply would become inadequate between 1985-1990; (19% reduction in per capita use before 1990).
	b. Annual use of treated water 181 mgd (1971-75); maximum single day use 480 mgd average.	b.
	c. Treated water storage capacity (DWB system) 287.8 million gal (1975).	c.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Socio-Economic Conditions (cont.)	d. Consumption rates of treated water (DWB service area) range 117 gdc (January) to 370 gdc (July) (1975); maximum single day is 608 gal (1973).	d.
	e. Irrigation uses 40% domestic use.	e.
	5. Law Enforcement: 47.6% of 6-county police in city and county of Denver.	5.
	6. Fire Protection:	6.
	a. 22 fire departments; 1,919 personnel; 209 pieces of equipment in 87 stations.	a.
	b. Town Index (Colorado-Wyoming) rating gave Denver "two" rating (very high); median for counties was "seven".	b.
	7. Community Attitudes: expression emanates from informed minorities.	7.
	a. Growth advocates who see plentiful water necessary;	a.
	b. Restricted growth factions;	b.
	c. Environmentalists;	c.
	d. Sectional differences between east/west slope;	d.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Socio-Economic Conditions (cont.)	e. One survey indicates receptivity to water conservation (1973).	e. Water rationing or conservation would be essential to maintain community services.
	8. Life Styles:	8. Life Styles:
	a. 10% of Denver area population below poverty level; average income for family of four is $21,092.	a.
	b. Domestic horticulture extensive.	b. Cut back horticulture irrigation.
Water Resources	1. Water rights: Under Colorado law, DWB has right to supply raw water to these treatment plants: Kassler (50 mgd), Marston (260 mgd), Moffat (210 mgd), and raw water users.	1. Water rights: the total amount of raw water available to DWB will remain at 312,300 ac-ft annually. Without additional raw water, this supply would become inadequate between 1985-1990.
	2. Flows and Reservoir Levels:	2. Flows and Reservoir Levels: average annual flows would increase until 1990 when raw water would be fully utilized. Channelization can accommodate up to 680 cfs.
	a. 1964-73 raw water 205,300 ac-ft per year average; 170,400 ac-ft treated per year average.	a.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Water Resources (cont.)	b. Moffat System: Williams Fork River, Fraser River, South Boulder and Ralston Creeks, to Moffat Treatment Plant 58,500 ac-ft (1975).	b.
	c. Roberts Tunnel System: Dillon Dam and Reservoir (254,036 ac-ft capacity) and Roberts Tunnel (1,000 cfs maximum capacity (1977)); inflow to Dillon average 187,500 ac-ft per year; 29,600 ac-ft average annual release Roberts Tunnel (1964-73).	c.
	d. South Platte System: average annual runoff (1964-73), 266,100 ac-ft; dependent on natural runoff, releases of stored water, and trans-mountain diversions; lowest average monthly flow in February, highest in June.	d.
	e. North Fork of the South Platte: dependent on natural runoff and Roberts Tunnel diversion from Dillon; channelization between east portal of Roberts Tunnel and Bailey, Colorado provides for sustaining flows of 680 cfs, and peak discharge of 1,020 cfs.	e.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Water Resources (cont.)	f. Miscellaneous Minor Waters	f.
	1. Willow Creek, Bear Creek, Stevens Gulch, unquantifiable discharges;	1.
	2. Plum Creek - 154,000 cfs maximum instantaneous flow (1965);	2.
	3. Spring Gulch, Marcy Gulch, Dad Clark Gulch, Willow Creek - unquantifiable drainages.	3.
	3. Ground Water:	3.
	a. Fissures pass water	a.
	b. Pierre formation is poor aquifer	b.
	4. Water Quality:	4.
	a. Physical, chemical, bacteriological data tabularized;	a.
	b. Public Health Standards tabularized.	b.
	c. CDW classes South Platte River as B-1 cold water fishery stream (1977).	c.
	d. Salinity of Colorado River at Cameo, Colorado is 440 mg/l, and at Imperial Dam, Arizona is 861 mg/l.	d.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Aquatic Resources	1. Fish populations: Special extent and distribution tabularized in South Platte River, Waterton Canyon, North Fork of the South Platte, Dillon Reservoir.	1. Fish populations: 60% reduction.
	2. Bottom Fauna: sampling data in text.	2. Bottom Fauna: 95% reduction.
	3. Aquatic Vegetation: none	3. Aquatic Vegetation: less in reservoir from drawdown.
	4. Amphibians: species data tabularized.	4. Fewer amphibians.
Geology, Minerals, and Topography	1. Topography and General Geology 2 provinces: southern Rocky Mountain and Great Plains.	1. Topography and General Geology: very little change except normal weathering modifications.
	2. Geologic Processes: sedimentation.	2.
	3. Minerals:	3. Minerals: USGS (1963) infers uranium and pegmatite minerals may be present in minable quantities.
	a. Radium, radon, uranium.	a.
	b. Limestone, clay.	b.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Geology, Minerals, and Topography (cont.)	4. Geologic Hazards and Problem Areas	4.
	a. Faults, joints, seismic activity, earthquake hazard discussed, not quantifiable.	a.
	b. Slides and rock falls discussed in text; hazard not quantifiable.	b.
Soils	1. Soil descriptions are mapped from 3 SCS soil surveys.	1. Soil development, erosion, and deposition would continue as at present; urban expansion in the flat area would decrease productive potential; erosion would increase in the canyon from increased flows and increased recreation.
	2. Soil descriptions and interpretations and specific soil properties tabularized.	2.
	3. Sediment Yields: 1974 - low yield 0.1-0.2 ac-ft per 640 acres per year (1/2 ton/ac/yr.) undisturbed; Disturbed - high yield - 1.0 ac-ft per 640 acres per year (3 tons/ac/yr.)	3.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Terrestrial Resources	1. Vegetation (1977): 3 vegetative zones, 4 basic plant communities, mapped in text and extent tabularized.	1. Vegetation: increased flows in North Fork of the South Platte River and South Platte would cause unquantifiable temporary destruction of riparian vegetation (and loss of wildlife habitat); however it would be re-established.
	2. Summary of vegetation and wildlife	2. Recreation pressure would decrease wildlife in the canyon. If sheep were replaced, the range can support 76 head.
	a. Bighorn sheep mapped	a.
	b. Endangered species	b.
	c. Peregrine falcon	c.
	d. Other animal species.	d.
Climate and Air Quality	1. Temperature - relation to altitude; average 45-50^{o} F, extremes of -35 to -40^{o}F in winter to 100^{o}F summer.	1.
	2. Precipitation: May highest month (2.75"); average annual precipitation 16".	2.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Climate and Air Quality (cont.)	3. Ambient Moisture and Evaporation: Ambient levels low, 15-24" per year pan evaporation.	3.
	4. Winds: no data in area; Denver prevailing wind south, 9.3 mph.	4.
	5. Air Pollution: no data, but total suspended particulates occasionally exceeded by fugitive dust.	5. Air pollution would increase with urbanization but the Air Quality Maintenance Plan (EPA 1974), would reduce carbon monoxide by 1981 and vehicular hydrocarbons by 1983. Nitrogen oxide would be acceptable at both years 1977 and 2010.
Noise	32-40 dBA low noise level.	Noise levels would remain the same.
Visual Resources	Visual elements discussed, rated, mapped and pictured.	Increased recreational use, channelization of the North Fork and additional developments would reduce visual integrity.
Cultural Resources Archaeological Resources	Archaeological potential discussed from data available for 1977.	Archaeological resources would evidence collecting and digging, as well as destruction through urban expansion.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Historical Resources	Historical sites tabularized; 106 protection listed; North Fork of South Platte Historic District is on National Register.	Deansbury Station and Strontia Springs sites should remain the same; railroad grades, cuts, and rockwork should remain the same.
Paleontological Resources	Two localities reported nearby study area, plus mammoth skull at Chatfield Dam and Paleocene deposits of vertebrates are considered likely.	The paleontological potential would remain the same.
Recreation	Type and extent of recreation utilized discussed and tabularized for:	
	1. Water Canyon (10,000 visits in 1976)	1. Waterton Canyon visitor pressure would increase; quality would depend on recreation management; Roxborough Park will expand 756 acres for 1,000 recreationists per day.
	2. South Platte river to Cheesman Reservoir	2. South Platte River to Cheesman Reservoir visits would double by 2010; USFS South Platte Planning Unit will be ready in 1980; USFS will expand recreation from 1980-2010;
	3. North Fork of the South Platte	3. High flows will limit recreation in North Fork of the South Platte;

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

TABLE 2-33 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action 1/
Recreation (cont.)	4. Treatment Plant Site	4. Chatfield Dam (1974) and reservoir will produce 1,300 surface acres of water recreation.
Land Use	1. Waterton Canyon - 1/3 DWB-owned; 2/3 public land (USFS/BLM)	1. Land use patterns will be similar to the present; patterns will be established by topographic features (Waterton Canyon), man-made feature (Chatfield Dam and Reservoir) and land use trends to intensive residential development (see maps).
	2. Denver expanding metro area	2. Utilities and roads would be upgraded by 73 acres annual aereal development near the conduits and 0.1 miles annually north-to-south.
	3. Small rural communities	3.
	4. Large and grazing holdings	4.
	5. Chatfield Dam (1975)	5.
	6. Discussion of raods (traffic volume tabularized)	6.
	7. Air traffic	7.

1/ Where there are blank spaces, no projection was possible for the corresponding aspect of the existing environment.

CHAPTER 3

ENVIRONMENTAL IMPACTS OF THE PROPOSAL

This chapter identifies and analyzes impacts of the proposed Foothills Project. Each impact is analyzed in a cause and effect manner; secondary impacts are identified and traced as far as practical.

The cause identified is tied to a component of the project proposal (Chapter 1) and the effect identified is tied to a component of the environment (Chapter 2). Existing environmental data were used to assess temporary or shortterm impacts, while both existing and projected future environmental data were used to assess permanent or longterm impacts.

ASSUMPTIONS AND ANALYSIS GUIDELINES

Impacts on the environment if the proposal is implemented will be analyzed using the following assumptions:

1. Impacts will be analyzed considering two levels of operation of the Foothills Treatment Plant: 125 mgd (million gallons per day) and 500 mgd.

2. Implementation will be 3 years from the granting of the rights-of-way permit for the 125 mgd plant, assumed here to be May of 1978; measuring impacts at this level of operation will begin then. It is assumed that expansion to 500 mgd will begin before 2001, since the 500 mgd will be required at that time, based on current population and use trends. Cumulative impacts for expansion to 500 mgd will be measured at the year 2001.

3. All project components will be assumed to last as long as the project is operational, here estimated at 75 years.

4. There will be no additional raw water supplies required for operation at the 125 mgd level before 1988. Additional raw water supplies must be available at that time in order to satisfy the projected treated water demand associated with the projected population and current water use trends.

5. In order to consider maximum impacts, the impact of providing additional raw water supplies will be considered at the maximum level of implementation, 500 mgd.

6. Obtaining additional raw water will, at some point, involve changes in the flows within sections of the South Platte River watershed. In Chapter 3, analysis of the impacts of

obtaining more raw water will begin at the highest upstream point on the South Platte River and its affected tributaries. Chapter 8, Alternatives, will contain a general analysis of impacts related to the development and operation of various facilities required to increase the DWB raw water supplies.

7. The assumed population growth during the period of the project will be based on projections of the Denver Regional Council of Governments (DRCOG) as shown in Table 14.

8. Any impacts over 30 years will be considered permanent.

9. The following data concerning individual project elements have been abstracted from the detailed description of the proposal and are assumed to be accurate data for impact analysis:

Project Elements	125 mgd development	500 mgd development
DAM		
Height, above stream bed	243 feet	N/A
Crest Elevation	6,002 feet	N/A
Crest Length	601 feet	N/A
Thickness	31 feet at base 10 feet wide at crest	N/A
Excavation	130,000 cubic yards	N/A
INTAKE TOWERS		
Denver Intake	A hexagonal structure 35 feet thick at the base and 179 feet tall.	N/A
Aurora Intake	A square structure 21 feet thick at the base and 123 feet tall.	N/A
RESERVOIR		
Normal Capacity	7,700 acre-feet at 6,002 foot elevation.	N/A
Silt-storage Capacity	2,110 acre-feet (75 years)	N/A
Surface Area	98 acres at 6,002 foot elevation.	N/A
Pool Length	1.7 miles at 6,002 foot elevation.	N/A
TUNNEL	17,967 feet in 3 segments	
Length	1,705 feet of 10.5-foot diameter concrete-lined tunnel from intake tower to Stevens Gulch. 170 feet of 10.5-foot diameter conduit in Stevens Gulch. 17,092 feet 10.5-foot diameter concrete-lined tunnel to the east portal.	N/A

Project Elements	125 mgd development	500 mgd development
Excavation	143,000 cubic yards 40% from Stevens Gulch 60% from East Portal	N/A
Aggregate Needs	53,000 cubic yards	N/A
TREATMENT PLANT COMPLEX		
Conduit 26 length	1,721 feet of buried 10.5-foot diameter pipe from east portal to the treatment plant.	N/A
Power generation (hydroturbine capacity)	11 million kilowatt-hours annually	78 million kwh annually
Aurora Intertie System	2 segments: 2,450 feet of 54-inch buried conduit 1,500 feet of 60-inch buried conduit	N/A
Treatment Capacity	125 mgd	375 mgd
Plant Structures	25 aboveground improvements	36 aboveground improvements
	9 underground structures	14 underground structures
	65 acres occupied by structures	49 acres occupied by structures
Sludge Production	Averages 4,490 pounds/day	Averages 28,500 pounds/day
Internal access	Asphalt surfaced road 3,700 feet long; Graveled road 2,600 feet long (temporary)	N/A
CONDUIT NO. 27		
Length	53,800 feet of 108-inch buried steel or concrete cylinder from treatment plant to Highland Reservoir.	53,800 feet of 108-inch buried steel or concrete cylinder from treatment plant to Highland Reservoir.
	33,000 feet of 90-inch conduit from Highland Reservoir to Hillcrest Reservoir.	33,000 feet of 90-inch conduit from Highland Reservoir to Hillcrest Reservoir.

Project Elements	125 mgd development	500 mgd development
Rights-of-way	60,800 feet at 100 feet wide or 140 acres.	same right-of-way as 125 mgd
	10,000 feet at 80 feet wide or 19 acres.	same right-of-way as 125 mgd
	16,000 feet; street right-of-way.	same street right-of-way as 125 mgd
Access	Temporary road paralleling conduit	Temporary road paralleling conduit
ACCESS ROADS AND STAGING AREAS		
Road Improvements	20,400 feet of 22' wide gravel surface.	N/A
	6,400 feet of 13' wide graded surface with turnouts.	N/A
POWER AND TELEPHONE LINES		
Dam and Stevens Gulch portal	13.2 kilovolt overhead lines, 2.8 miles with telephone lines on same poles.	N/A
Treatment Plant and East Portal	12.6 kilovolt overhead line, 2,500 feet with telephone lines on same poles.	N/A
MANPOWER DATA		
Construction	Average of 400 persons per year working three eight-hour shifts seven days a week for three years.	Average of 27 persons per year work three eight-hour shifts seven days a week for seven years.
Operation and Maintenance	25 workers for the life of the project - 75 years.	10 additional workers for the life of the project - 75 years.

SOCIO-ECONOMIC CONDITIONS

Human Populations

As proposed, the Foothills Project would not alter future population trends in the Denver metropolitan area (assumption 7 at the beginning of this chapter). There appear to be economic, social, scenic, recreational, and climatic aspects of the Denver area that have caused continuous in-migration at a rate greater than the national average since World War II (Bureau of the Census 1970). This conclusion is based on the knowledge that, with certain adjustments in life styles, the available water supply in the area would support a considerably larger population. ("Water rationing-education program", Chapter 8).

Employment and Manpower

The number of unemployed construction workers in the DBLMA in March 1977 was 3,753 (Table 2-1). Since a maximum of 460 workers would be employed during the construction of the first 125 mgd capacity of the project (Figure 1-2) and assuming that the number of unemployed construction workers would not change, the peak impact of constructing the first 125 mgd capacity of the project would be to reduce unemployment among construction workers by 12.3 percent.

An average of 400 workers would be employed annually over the three-year construction period of the 125 mgd facility. Again, assuming stability among the number of unemployed construction workers, the impact would be to reduce unemployment among the workers an average of 10.7 percent over the three-year period.

An additional work force averaging 27 workers per construction year for seven years would be required to expand the project to the 500 mgd level. If the number of unemployed among construction workers remains stable at 3,753, the impact of this construction would be to reduce unemployment among these workers by 0.7 percent over the seven-year construction period.

An estimated 25 people would be employed for operation and maintenance of the 125 mgd facility and an additional ten people would be required for operation and maintenance at the 500 mgd level, making a total work force of 35 maintenance workers for the duration of the project. Assuming continued stability among the number of unemployed transportation and public utilities workers, which was 649 during March 1977 (Table 2-1), the project would reduce unemployment among these workers by 5.4 percent.

Accidents

Construction of the Foothills Project would probably result in work-related accidents involving vehicles and workers. Table 3-1 summarizes the accidents causing lost time anticipated during construction and operation of the project. During the three years of construction, an estimated 43 accidents would occur, each resulting in injury with loss of at least one work day. Construction of additional increments to implement the 500 mgd capacity would result in an estimated 88 additional accidents. During the 75-year life of the operating facility, there would be an estimated twenty accidents involving motor vehicles supplying the treatment plant with supplies and chemicals. Transport trucks hauling chlorine would probably be involved in about seven accidents and ammonia transports would probably be involved in about three accidents (Table 3-1). Although statistics are not available to predict the frequency of serious vehicular collisions or major accidents that might result in a toxic chemical spill, the DWB indicates it has never experienced such an accident. In general, accidents would be expected to occur at the rate of one every eleven years for chlorine transports and one every 22 years for ammonia transports. Because of the way the transports are designed, it is improbable that a rupture and chemical spill would occur.

Income

The estimated cost of constructing the first 125 mgd increment of the project would be about $133,539,000, which would be expended over a three-year period; this would amount to an average of about $44,513,000 annually. The estimated total gross 1975 domestic product in the Denver area is $7,277,400,000 (DRCOG 1974c). Therefore, if the entire expenditure for the project were local, it would have the direct effect of adding 0.6 percent to the gross domestic product. There would also be undetermined multiple effects.

However, over the three-year construction period, there would be significant human impacts on approximately 400 families and/or individuals (the average number which would be hired during the construction period), who would receive average annual gross incomes of about $16,000. Some local subcontractors would also receive significant income. The DWB concluded that it would be impossible to calculate subcontractor income at this time.

Expansion to the 500 mgd level will result in an additional $131,084,000 being spent by 2001, resulting in an economic impact even smaller than that of the first increment. There will be, however, significant positive impacts on the average of 27 worker families and/or individuals, who will earn annual incomes not less than $16,000 over the seven-year construction period involved in expanding to the 500 mgd level.

TABLE 3-1

ANTICIPATED LOST TIME ACCIDENTS
DURING CONSTRUCTION AND OPERATION OF THE FOOTHILLS PROJECT

Type of Work	1974 Accident Rate in Incidents per 1,000,000 Hours Worked 1/	Probable Number of Accidents Related to Construction of Phase I of the Foothills Project (125 mgd)	Probable Number of Accidents Related to Construction of Phases II, III and IV of the Foothills Project (500 mgd)	Total Number of Accidents	Probable Accidents during 75 years of Operation
General construction (approximately 300 workers annually)	13.50	21	35	56	Not applicable
Underground mining (approximately 50 workers annually)	25.26	6	Not applicable	6	Not applicable
Motorized transport (trucks)	9.36 2/	16	53	69	20 3/

1/ National Safety Council 1974.

2/ Units in incidents per one million miles.

3/ Breakdown of accidents related to transport trucks includes the following: (1) Chlorine transports - 7 accidents; (2) Ammonia transports - 3 accidents; (3) Other supply transports - 10 accidents. Based on an average distance of 40 miles per delivery according to delivery frequency cited in Table 1-11.

The total cost of the 500 mgd project would be $264,623,000, an average of $2,646,230 annually for a ten-year period. This would have a very small impact on Denver's $7 billion plus economy, about 0.036 percent annually.

The impact of operation and maintenance on gross income earned in the Denver area would be slight since it would involve only 25 to 35 new jobs for workers, all at the treatment plant. However, the impact on families of these workers would be significant; they would be assured a steady income, which traditionally has been a key variable in a stable family life.

The social impact of constructing the project on persons who are opposed to it would be difficult or impossible to quantify without the use of a scaled questionnaire applied to a random sample of the affected population. It can be assumed that there would be a negative social impact on them. But the project could have a positive social impact on these people, by permitting them to continue their current lifestyle.

UTILITIES

Municipal and Industrial Water Systems

The construction of the Foothills Project at a capacity of 500 mgd would enable the DWB to meet projected maximum-day requirements through the year 2001 (Table 1-4). Availability of the Foothills' 125 mgd treatment capacity in addition to present facilities would essentially eliminate maximum-day shortages during the peak-use periods through 1988. By 1988, additional treatment capacity would be required because maximum-day demands would continue to increase with population. In addition, the availability of additional reliable raw water supplies would remove constraints on the use of treated and raw water within the DWB service area.

Table 3-2 displays the projected use of water within the DWB service area compared to the supply available with the treatment capacity increased by 125 mgd (to 645 mgd) and with no increase beyond present raw water supplies. Beginning in 1988, additional treatment capacity and more raw water would be required to provide treated water for the projected population at levels consistent with current use trends.

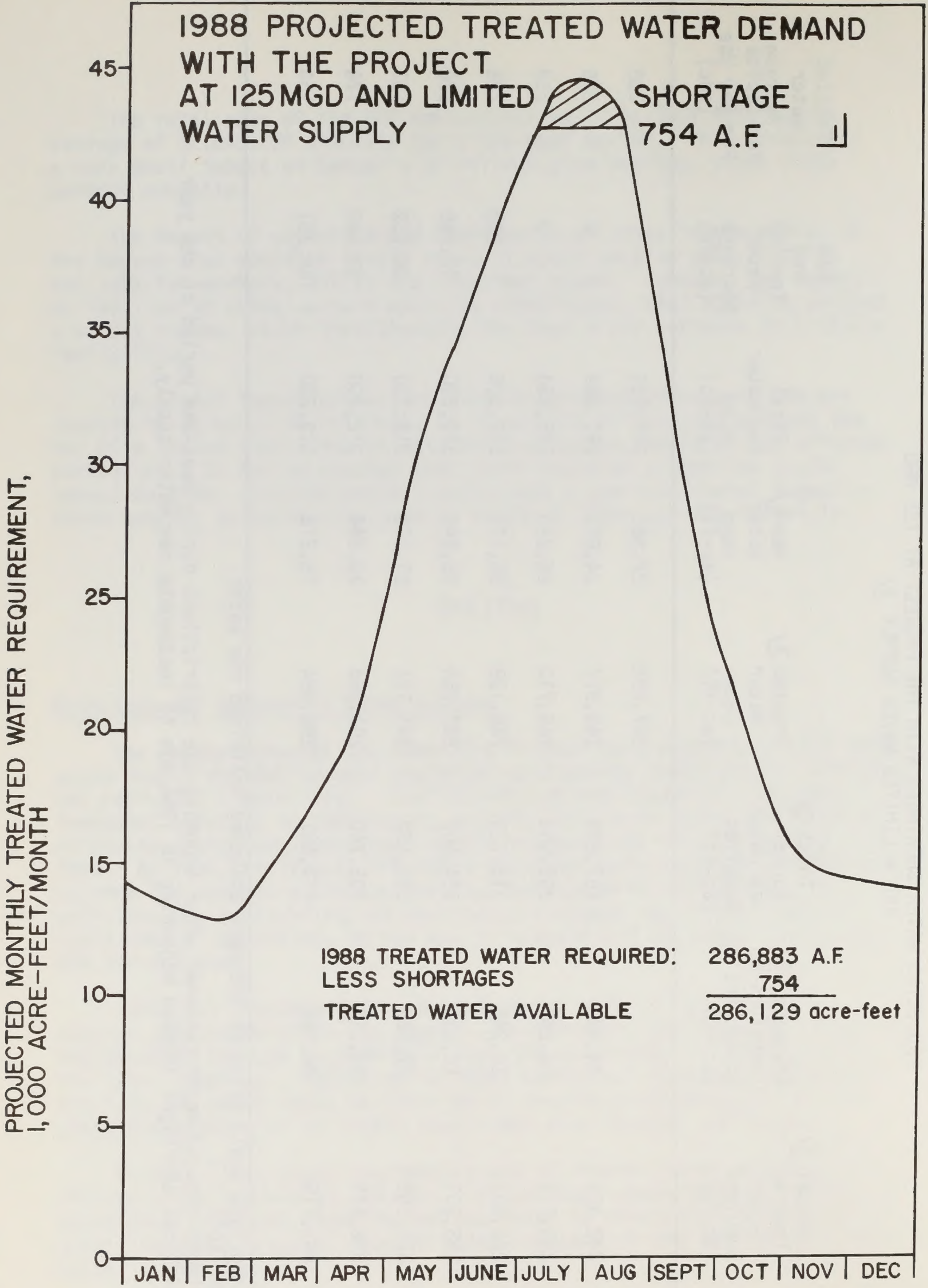
Figure 3-1 displays the monthly use of treated water expected in 1988 with the project at 125 mgd. The shortage shown indicates that additional treatment capacity and raw water is required. Figure 3-2 shows the monthly use of treated water expected if the 500 mgd Foothills plant is implemented.

TABLE 3-2

PROJECTED WATER SHORTAGES WITH THE PROJECT AT 125 MGD AND A LIMITED WATER SUPPLY 1/

Year	Annual 2/ Treated Water Required (ac-ft)	Raw Water 2/ Diversions to Other Uses (ac-ft)	Total 2/ Annual Raw Water Required (ac-ft)	Treated 3/ Water Used (ac-ft)	Raw 4/ Water Used (ac-ft)	Total Raw Water Used (ac-ft)	Raw and Treated Water Shortage (ac-ft)	Treated Water Average Per Capita Per Day Use (gdc)
1975				207,982	27,883	235,865		208
1980	242,977	24,922	267,899	242,977	24,922	267,899	0	226
1985	269,710	26,243	295,953	269,710	26,243	295,953	0	228
1988	286,883	26,240	313,123	286,129	26,171	312,300	823	228
1990	298,331	26,238	324,569	287,054	25,246	312,300	12,269	220
2000	371,509	27,023	398,532	291,124	21,176	312,300	86,232	181
2001	378,530	27,210	405,740	291,356	20,944	312,300	93,440	178
2010	441,719	28,962	470,681	293,084	19,216	312,300	158,381	154

1/ No shortage would exist at 500 mgd, assuming unlimited raw water.
2/ From Table I-2
3/ Reflects treated water consumed after imposing use restrictions during peak-use period of the year.
4/ Additional shortages imposed beginning in 1988 due to inadequate raw water supply.



1/ Shortages predicted upon inability to satisfy treated water demand.

FIGURE 3-1

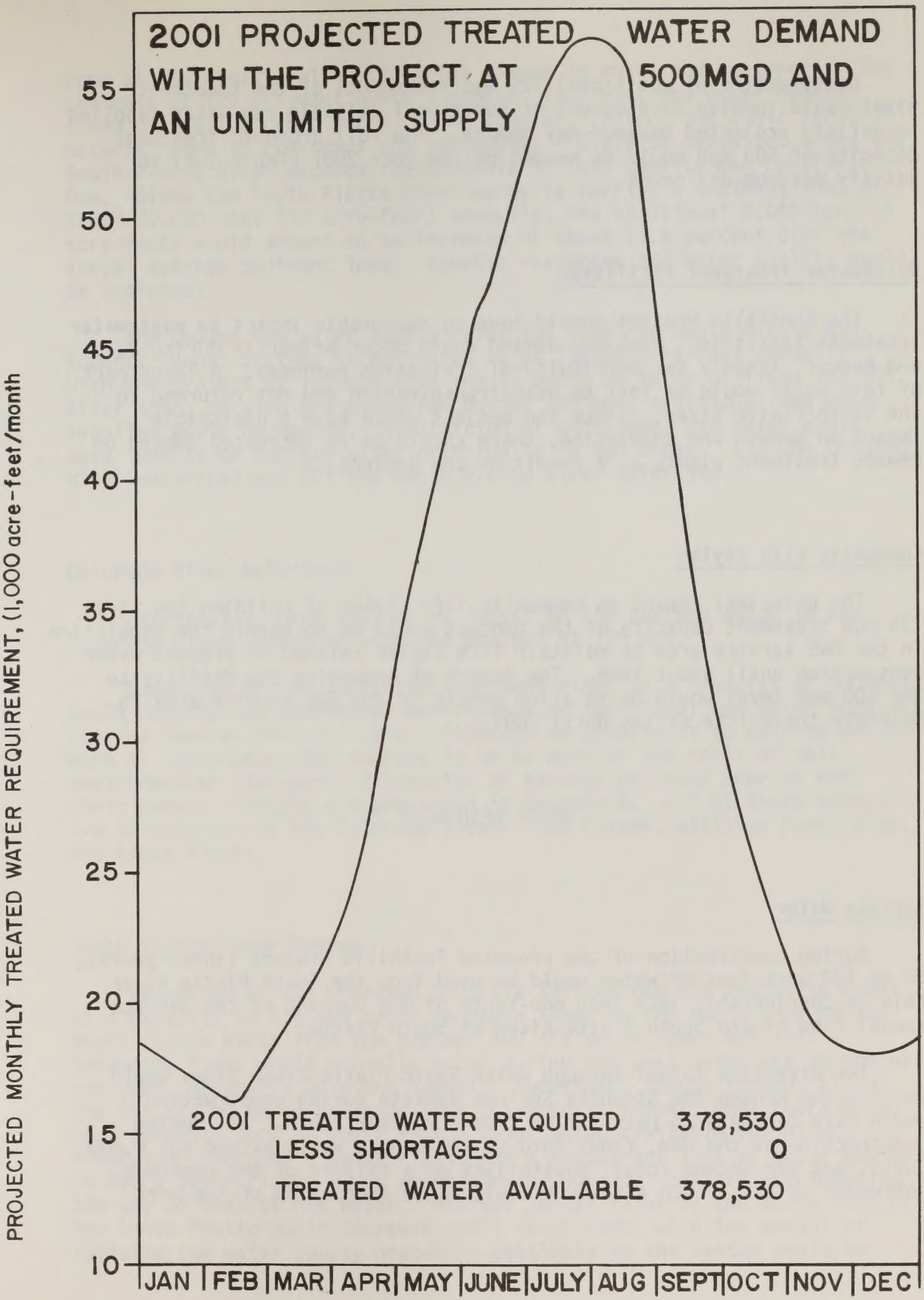

2001 PROJECTED TREATED WATER DEMAND
WITH THE PROJECT AT 500MGD AND
AN UNLIMITED SUPPLY
PROJECTED MONTHLY TREATED WATER REQUIREMENT, (1,000 acre-feet/month
55
50
45
40
35
30
25
20
15
10
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
2001 TREATED WATER REQUIRED 378,530
LESS SHORTAGES 0
TREATED WATER AVAILABLE 378,530

FIGURE 3-2

Construction of additional 125 mgd increments of the treatment plant would involve development of additional reliable raw water supplies to satisfy projected maximum-day demand. The full proposed treatment capacity of 500 mgd would be needed by the year 2001 (Table 1-4) to satisfy maximum-day needs.

Wastewater Treatment Facilities

The Foothills Project should have no measurable impact on wastewater treatment facilities. Peak-day demand would occur primarily during July and August, largely for horticultural irrigation purposes. A large part of this water would be lost to evapotranspiration and not returned to the South Platte River. Since the project would have a negligible impact on growth and population, there should be no increased demand on sewage treatment plants as a result of the project.

Community Life Styles

The principal impact on community life styles of building the first 125 mgd treatment capacity of the project would be to permit the population in the DWB service area to maintain life styles related to present water consumption until about 1988. The impact of expanding the facility to the 500 mgd level would be to allow people in the DWB service area to maintain these life styles until 2001.

WATER RESOURCES

Surface Water

During construction of the proposed Foothills Project (three years), 90 to 100 acre-feet of water would be used from the South Platte River. This is considerably less than one-tenth of one percent of the average annual flow of the South Platte River at South Platte.

The diversion tunnel through which South Platte River flows would be diverted around the Strontia Springs damsite during construction would have capacity to pass a flow from a 25-year storm. If, during construction of the dam, flows through the canyon would exceed the 4,400 cubic feet per second (cfs), possibility of a failure of the upstream cofferdam exists. Such a failure would cause inundation of the work

area at the damsite with associated damage to works and equipment. The contents of the sediment basin - grease, concrete, and other debris, along with 6,700 cubic yards (8,040 tons at 1.2 tons per cubic yard) of material used to construct the cofferdams - would be deposited along the South Platte River between the Strontia Springs damsite and Chatfield Dam. Since the South Platte River normally carries a sediment load of about 70,000 tons (36 acre-feet) annually, the additional 8,040 tons (4 acre-feet) would amount to an increase of about 11.5 percent over the annual average sediment load. Aquatic resources and water quality would be impacted.

The unused raw water supply resulting from the South Platte and Roberts Tunnel Systems is estimated to be 79,100 acre-feet annually. With the project at 125 mgd this supply would be fully utilized in 1988. After that, or with any expansion beyond 125 mgd, additional raw water supplies would be needed. Acquisition of additional raw water would have impacts on surface water principally in two areas: (1) the Colorado River watershed and (2) the South Platte River watershed.

Colorado River Watershed

Essentially there will be no impact on the surface water in the Colorado River watershed with the project at 125 mgd.

Expansion of the Foothills Treatment Plant to a capacity of 500 mgd would require the concurrent development of additional raw water supplies. Several sources are available. Although no commitment to develop one or more of these potential sources is to be made on the basis of this environmental statement, discussion of several of these sources and their general impacts are presented in Chapter 8. All of these sources are tributaries of the Colorado River: the Fraser, Williams Fork, Blue, and Eagle Rivers.

South Platte River System

Operation of the proposed Strontia Springs Dam and Foothills Plant at a capacity of 125 mgd could increase flows on the North Fork of the South Platte River from the present 400 cfs up to about 595 cfs. Increased flows would normally occur during the peak water-use period of the year, generally July and August. Sometimes, though rarely, all of the 595 cfs might be released from the Roberts Tunnel, when there would be a complete lack of South Platte River water available for direct diversion under DWB's water rights and a concurrent lack of water stored in DWB's South Platte River reservoirs or physical constraints impeding the use of that stored water. Average annual flows on the North Fork of the South Platte would increase until about 1988, when the amount of reliable raw water supply presently available to the system would be

fully utilized. Projected average annual flows at a number of locations in the South Platte River watershed are shown on Table 3-3.

Table 3-4 presents average monthly discharge at several locations within the South Platte River watershed with the additional Roberts Tunnel water and the Foothills plant in operation at a capacity of 125 mgd. These flows are based on the assumptions listed below.

1. Operation of Foothills Project and full utilization of the reliable water supply of South Platte and Roberts Tunnel system is superimposed upon the average streamflow and diversions as reflected by the ten-year period, 1964-73.

2. Average monthly streamflow of the South Platte River at Waterton is representative of the flow anticipated to occur after the initial unit of the Foothills Plant becomes operational in the event of the recurrence of a similar ten-year period. Exchange of transmountain sewage effluent and acquisition of additional water rights would reduce the flows at Waterton.

3. Historical diversions in the reach of the South Platte River between South Platte and Waterton for other than DWB treated water purposes would remain the same (31,900 acre-feet).

4. Moffat Treatment plant would operate for a six-month period, April through September.

5. The values of discharge so derived are not absolute due to the vagaries of climatic, hydrologic, and demand conditions from year to year. Absolute prediction of the pattern of operation of the DWB treatment facilities cannot be determined.

Due to the elevation of the Foothills Treatment Plant site, the proposed facility would be operated year-round as a base load plant rather than limited to the peak-use period of the year. In 1988, if the plant were operating at a capacity of 125 mgd continuously year-round, the flows diverted at Strontia Springs would be 193 cfs (125 mgd).

Average annual flows in the reach of the South Platte River between Strontia Springs damsite and the Platte Canyon Intake Diversion Dam have averaged about 298,000 acre-feet per year (1964-73), or 412 cfs. With the project operating at 125 mgd and full utilization of South Platte River and Roberts Tunnel system reliable raw water supplies in 1988, the annual flows at Strontia Springs Reservoir would average 377,100 acre-feet, or 521 cfs. Flows downstream of the Strontia Springs Dam after diversion of 193 cfs (125 mgd), assuming year-round operation of the Foothills Plant, would average 328 cfs.

TABLE 3-3

PROJECTED AVERAGE ANNUAL FLOW AT KEY GAGING STATIONS
WITH THE FOOTHILLS PROJECT AT 125 MGD.

Gaging Station	Projected Discharge 1988	
	cfs	ac-ft
South Platte River below Cheesman Dam	117	128,200
Roberts Tunnel Imports	156	112,900
North Fork South Platte below Grant with Roberts Tunnel	224	162,300
North Fork South Platte at South Platte with Roberts Tunnel 1/	307	222,600
South Platte River at South Platte with Roberts Tunnel 1/	521	377,100
South Platte River below Denver 2/	711	514,600

1/ Flows reflect assessed losses of 5 percent on Roberts Tunnel diversions.

2/ Includes the sum of South Platte River at 19th St. gage plus estimated sewage return (57 percent of additional Roberts Tunnel import) and gaged discharge of Clear Creek at mouth.

TABLE 3-4

PROJECTED MONTHLY AVERAGE DISCHARGES (IN CFS) IN THE NORTH FORK SOUTH PLATTE RIVER AND THE SOUTH PLATTE RIVER AT 125 MGD IN 1988 1/

Month	Future Roberts Tunnel Imports 2/	North Fork South Platte at Grant	North Fork South Platte at South Platte	South Platte River at South Platte
January	142	159	181	248
February	136	151	172	237
March	135	153	178	258
April	175	201	258	463
May	169	291	511	1063
June	55	297	531	951
July	131	287	416	816
August	240	325	442	758
September	199	246	309	504
October	193	231	280	395
November	148	177	216	307
December	143	165	185	255
Annual Average Flow (in cfs)	156	224	307	521
Annual Average Flow (in acre-feet)	112,900	162,300	222,600	377,100

1/ The future imports have been reduced by five percent loss at South Platte stations.

2/ Based on population projections and historical use patterns, the 112,900 acre-feet raw water available in Dillon Reservoir would be in use by 1988.

Average monthly flows of the South Platte River below Strontia Springs Dam and the Platte Canyon Intake Diversion Dam where derived using the previously discussed assumptions as shown on Table 35.

Projected average monthly discharge on the North Fork of the South Platte River at Grant with the Foothills Plant operating at a capacity of 125 mgd are within the sustainable level of 680 cfs incorporated in the channel stabilization work completed to date.

Description of the impacts associated with the operation of a Foothills Plant with a capacity of 500 mgd are very difficult to assess at this time. As was discussed in Chapter 1, under Proposed Action, the operation at Capacity 500 mgd of the Foothills Treatment Plant would create a maximum instantaneous demand for raw water of up to 775 cfs on the South Platte River at the Strontia Springs Diversion Dam. This is 580 cfs more than the maximum flow required at 125 mgd and would result in the flows of greater velocity and increased depth.

If the Marston and Kassler Treatment Plant intakes would also use water at capacity, there would be a maximum instantaneous total demand for raw water from the South Platte River of 1,175 cfs. This would generally occur during the peakuse period of the year. Availability of water to meet such a requirement would depend on the locations of facilities providing additional water.

Several facilities which can provide raw water for treatment at the proposed Foothills Plant site are described in Chapter 8. The facilities include Chatfield Dam and Reservoir, Two Forks Dam and Reservoir, and additional collection facilities in the Blue and Eagle River watersheds. Exchange of transmountain sewage effluent with senior water users on the South Platte River downstream of Denver and the acquisition of water rights would also permit the diversion of additional water from the South Platte River for treatment.

Implementation of any one or combination of these would impose somewhat different flow patterns on the Eagle and Blue River watersheds. These patterns would vary with the location of the new facilities and the amount of water diverted. The same is true in the South Platte River watershed.

Flows downstream of the DWB diversion facilities in the Waterton Canyon would be reduced through transmountain sewage effluent exchange and water rights, the amount depending on exchange criteria and the water rights acquired.

The annual flows in the North Fork South Platte River would increase over those for operation of the Foothills Plant at 125 mgd with any of these facilities, the amounts of flows and discharge patterns varying with which facilities are developed. Further discussion of the gross impacts associated with the potential additional raw water facilities is presented in Chapter 8.

Average monthly flows of the South Platte River below Strontia Springs Dam and the Platte Canyon Intake Diversion Dam where derived using the previously discussed assumptions as shown on Table [illegible].

Projected average monthly discharge in the North Fork of the South Platte River at Grant with the Foothills Plant operating at a capacity of 125 mgd and within the sustainable level of 480 afy incorporated to the channel stabilization work completed to date.

Description of the Housing associated with the operation of a Foothills Plant with a capacity of 500 mgd is very difficult to assess at this time. As was discussed in Chapter 7, under Proposed Action, the operation at capacity and top of the Foothills Treatment Plant would create a maximum instantaneous demand for raw water of up to [illegible] cfs on the South Platte River at the Strontia Springs Diversion Dam. This is [illegible] cfs more than the maximum flow recorded at [illegible] and and would result in the flows of greater velocity and increased depth.

If the Foothills and Marston Treatment Plant intakes would also take water at capacity, there would be a maximum instantaneous total demand for raw water from the South Platte River of 1,[illegible] cfs. This would generally occur during the peakers period of the year. Availability of water to meet such a requirement would depend on the locations of facilities providing additional water.

Several facilities which can provide raw water for treatment at the proposed Foothills Plant site are described in Chapter 8. The facilities include [illegible] and Reservoir, Two Forks Dam and Reservoir, and additional collection facilities in the Blue and Fraser River watersheds. Exchange of [illegible] sewage effluent with senior water right on the South Platte River downstream of Denver and the acquisition of water rights would also permit the diversion of additional water from the South Platte River for treatment.

Implementation of any one or combination of these would require somewhat different flow patterns on the South and Blue River watersheds. These patterns would vary with the location of the new facilities and the amount of water diverted. The same is true in the South Platte River watershed.

Flows downstream of the DWD diversion facilities in the Waterton & Canyon would be reduced through increased sewage effluent exchanges and water rights, the amount depending on exchange criteria and the water rights acquired.

The annual flows in the North Fork South Platte River would increase over those for operation of the Foothills Plant at 125 mgd with any of these facilities, the amounts of flows and discharge patterns varying with which facilities are developed. Further discussion of the given impacts associated with the potential additional raw water facilities is presented in Chapter 8.

Water Quality

Impacts on the surface water quality in the Colorado River watershed with the project at 125 mgd would be the same with or without the proposed action. Therefore, such impacts are described in Chapter 8, under the No Action alternative.

Presentation of the water quality impacts in the Colorado River watershed associated with the 500 mgd treatment plant is made in Chapter 8, as a part of the discussion of the raw water concepts. Increased diversions from the Colorado River watershed would remove salts from the basin and increase salinity concentrations downstream.

The water quality of the South Platte River 1.7 miles upstream and 2.6 miles downstream of the construction area would be affected by the addition of sediment from disturbed areas during construction. Sediment would derive from reservoir construction, clearing vegetation in the reservoir area, road construction, and power and telephone line construction.

During the three years required for reservoir construction, about 75 tons (0.04 acre-feet) of additional sediment would be carried into the South Platte River annually from this source. Seventy tons of sediment would be generated during the first year from disturbed areas created during road construction and another 12.5 tons would be generated during the first year from areas disturbed by power and telephone line construction. Most of these sediments would be added to the South Platte during the predicted eleven storms when precipitation exceeds 0.5 inches. During the first year of the three-year construction period, about 157.5 tons (0.08 acre-feet) of sediments would be added to the South Platte River, which is currently carrying a full bedload of 70,000 tons (36 acre-feet) of sediments annually past a given point. The additional 157.5 tons of silt would probably drop to the bottom downstream as the river regains a balanced condition. Eventually, the additional sediments would reach the South Platte intake. There would be no impacts on water quality below this point. How the additional sediment would affect turbidity cannot be predicted. There is no known method to correlate additional amounts of particulate matter to increased turbidity (measured in JTUs), since it is dependent on reflective characteristics of the particles, such as shape and size.

The quality of the water impounded in Strontia Springs Reservoir would be dependent on the quality of inflows. With the high water-exchange rate anticipated for the reservoir, there probably would be little time for the geologic or climatic forces within the canyon area to affect the water quality to any great extent. Table 3-6 shows the estimated water quality values for the impounded water, based on the characteristics of inflowing waters. Water released from the reservoir would probably be of a quality similar to that impounded except that sediment load would be less. This sediment bedload would be reduced by 78 percent of capacity, from 70,000 to 15,600 tons annually (Geology, Topography, and Minerals section of this chapter).

TABLE 3-6

PREDICTED AVERAGE QUALITY OF WATER
IN THE STRONTIA SPRINGS RESERVOIR

Variable	Maximum 1/	Average Range 1/	Minimum 1/
Water temperature (°F.)	72.00	43.00- 48.00	32.00
Turbidity (JTU)	70.00	1.10- 8.00	0.10
Color units	100.00	11.00- 48.00	5.00
Conductivity (microhms)	455.00	166.00-315.00	100.00
pH (SU)	8.00	7.50- 7.80	7.10
Total alkalinity	112.00	56.00- 84.80	30.00
Total solids	285.00	120.00-183.50	26.00
Nitrate	0.55	0.07- 0.16	--
Phosphate	0.30	0.06	--
Total hardness	162.00	74.00-118.00	55.00
Calcium	40.00	21.30- 29.80	16.00
Magnesium	16.00	5.00- 10.00	2.30
Sodium	34.60	4.50- 26.00	2.70
Chloride	51.00	5.50- 30.00	0.20
Sulfate	75.60	32.00- 43.60	15.00
Fluoride	1.41	0.52- 1.10	0.35
Iron	0.84	0.09- 0.35	--
Manganese	0.29	0.05- 0.07	--
Coliform (100 ml)	6,000.00	0.00-240.00	--

Source: DWB 1974.

1/ Units are expressed in milligrams per liter except as where noted otherwise.

The net effect on water quality would be to reduce the turbidity in the 2.6 miles of the South Platte River between the Strontia Springs Dam and the South Platte Intake. The net effects of sedimentation from disturbed areas would be insignificant since the river would be picking up sediments to regain its lost bedload. It is probable that the estimated 49.5 tons (0.03 acre-feet) of sediment added from disturbed areas during the first year of reservoir operation would be picked up by the river and quickly deposited in the South Platte intake. There would be increased turbidity (not measurable), but it would probably not result in adverse impacts since the river would still be carrying sediments far below capacity.

Ground Water

Geologic formations that would be penetrated by the Foothills Tunnel are not known aquifers; however, it is possible that unknown weak aquifers in the sedimentary rocks near the east portal and in fracture zones in the metamorphic rocks could contain ground water. Excavation of the tunnel through formations containing ground water would result in leakage into the unlined tunnel and drainage to the low end of the tunnel.

An undetermined amount of water would be lost from the ground water source between the time the tunnel was excavated and the time it was lined with concrete (one to twelve months for the main tunnel and one to five months for the tunnel from the reservoir to Stevens Gulch). The water would flow to the low end of either tunnel into sediment basins or treatment reservoirs where sediments would settle out.

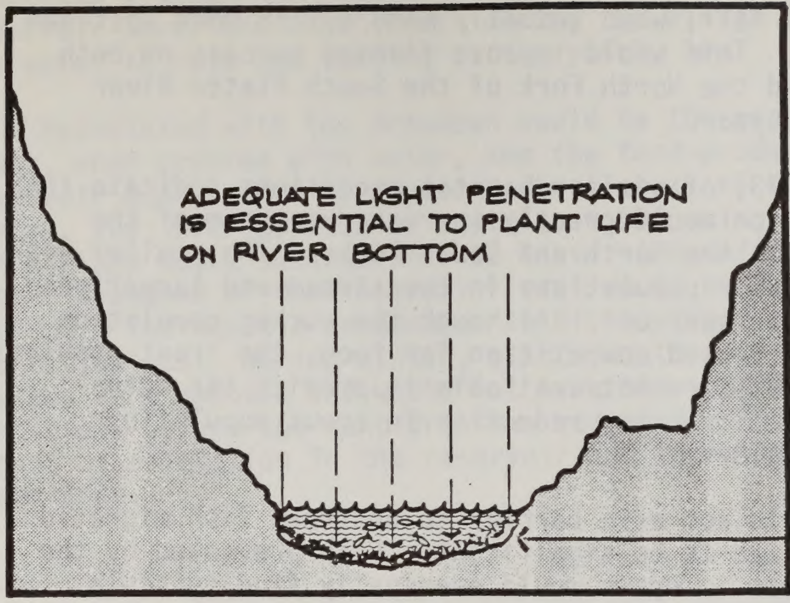
AQUATIC RESOURCES

During construction of the proposed dam, the bypass tunnel would remove water from the site and eliminate about 1 acre of aquatic habitat in the South Platte River. About 64 pounds of naturally reproduced rainbow and brown trout would be lost annually over the nearly 3 year construction period, or a total of 192 pounds of trout.

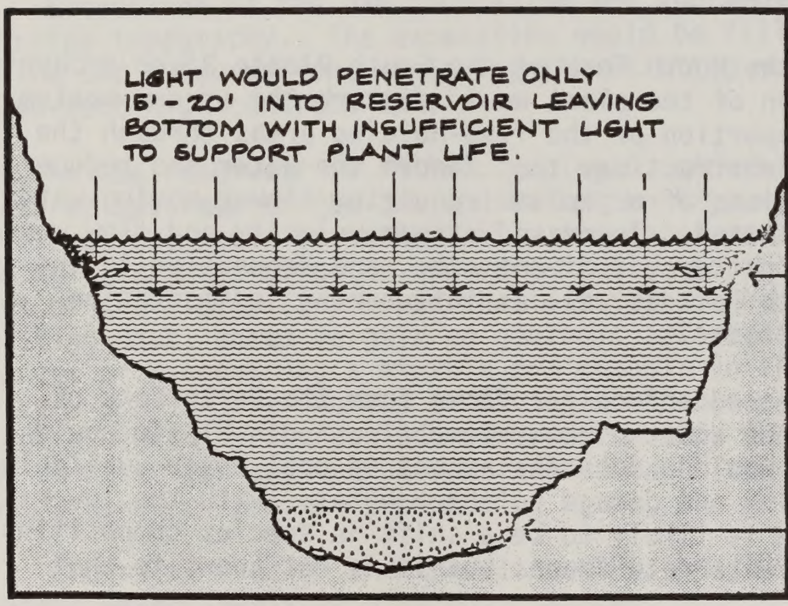
Siltation during construction in the Waterton Canyon would have several effects on the fish populations. It would reduce the food supply (bottom fauna) by suffocating the organisms or destroying their habitat. Silt would cover the suitable spawning grounds, thereby reducing the fish population by lowering its reproductive potential. More directly, silt would cover the gill filaments of the fish, resulting in suffocation. Because of these factors, natural productivity of aquatic life would be reduced in the 2.6 miles of stream from the dam site to the existing Platte Canyon Intake by about 10 to 20 percent (average 15 percent) during the three-year construction period. Once the dam began to operate and hold back sediments, the river should regain most of its aquatic productivity within one year. This represents a loss of about 12 pounds of fish per acre (15 percent of 78 pounds) per year, or about 408 pounds of fish annually, in the 34 acres of stream - a total of 1,224 pounds for the three-year construction period.

When operational, the proposed 95-acre reservoir would permanently convert 1.7 miles of the South Platte River into a standing body of water. Although the DWB anticipates little fluctuation of the reservoir level, the steep walls of the canyon would reduce the littoral or productive zone by reducing sunlight. This concept is illustrated in Figure 3-2. This reduction in sunlight combined with the effect of the water-exchange rate (ten days) would reduce plankton growth. Without a strong plankton base, the first link in the food chain is weakened and natural fish production is reduced. Estimates are that the standing crop of fish in the stream would be reduced from about 64 pounds of naturally reproduced rainbow and brown trout per acre to approximately 21 pounds. Even the 21 pounds of trout per acre would have to develop from downstream migration since rainbow and brown trout do not spawn in reservoirs. Although per-acre production would be reduced, an increase from about 14 acres of stream with 3.4 miles of shoreline to 95 acres of reservoir with 4.9 miles of shoreline would result in an increase in total fish biomass from 896 pounds to 1,995 pounds. This increase in biomass would probably be mainly non-game fish such as suckers. Therefore, the increased biomass would be of little or no value to fishermen.

Nothing, however, would offset the loss of suitable spawning areas in the 1.7 miles of stream to be inundated. Since rainbow and brown trout would not be able to spawn in the reservoir they would move upstream in both spring and fall for that purpose. Increased numbers and



Existing River – Productive Conditions



Typical Reservoir – Unproductive

Source: DWB, 1974

CROSS SECTIONS
South Platte River Canyon

FIGURE 3-3

catches of larger rainbow trout would be probable in the spring and larger brown trout in the fall, when sexually mature fish move upstream to such spawning grounds. This would improve fishing success on both the South Platte River and the North Fork of the South Platte River during those times of the year.

Studies by Erman (1973) of similar habitat conditions indicate that the non-game fish population would greatly increase upstream of the reservoir and upstream into the North and South Forks. The smaller year classes would dominate sucker populations in the stream and larger year classes would dominate the reservoir. Although the sucker population would benefit from the increased competition for food, the trout population would probably suffer. Data are not available to predict the actual effect on the trout population. Any reduction in trout populations would affect recreation values.

Although the dam would act as a barrier to upstream fish migration, the effects are not expected to be significant. Fish prevented by the dam from migrating upstream to spawn would eventually find suitable gravels below the dam.

The dam and reservoir would destroy one amphibian pond; however, it is possible that others would be created in the Bear Creek or Willow Creek arms of the reservoir.

Increased flows in the North Fork of the South Platte River occurring with the 500 mgd operation of the plant would disturb the stream bottom and eliminate a large proportion of the fish-holding areas through the elimination of pools and obstructions that deepen the water and reduce the current. The populations of organisms requiring slower moving water would be reduced or eliminated. Increased stream velocity and flow would also affect the movement pattern, sediment size, and deposition in the stream bottom of the North Fork as well as influencing sedimentation downstream in the South Platte.

As a result of increased and colder flows from the North Fork of the South Platte River, the aquatic ecosystem below South Platte would change. Increased flows would reduce the amount of pool cover available to the fish, cause scouring and damage to the habitat. With the lower water temperatures, there is likely to be a shift in species composition of the vertebrate and invertebrate fauna, but it is not known to what extent this would occur.

The 44-foot drawdown of Dillon Reservoir associated with the 125 mgd operation would cause the present fish population to be concentrated in a smaller area. Larger, more predatory fish would utilize the smaller fish, finally resulting in fewer but larger fish in the reservoir. Brown trout would be the main recipient of the drawdown, because they are able to out-compete the other trout (rainbow, brook and Kokanee).

Reduction of the fish population would probably be small, because the reservoir level would be lowest during the winter and early spring, when the water is cold and feeding at the yearly low.

Associated with the drawdown would be the exposed mud flats. These areas, when covered with water, are the food-producing zones for the reservoir ecosystem. By exposing these areas to cold air during the winter, any invertebrates or reptiles hibernating in the mud before it was exposed would subsequently be lost. A benefit from the annual winter drawdown of the reservoir level would be aquatic vegetation control. The aquatic vegetation in Dillon Reservoir is a menace to recreationists. During winter, plants would freeze out when their root systems were exposed and would not have the opportunity to re-establish completely before the next drawdown occurred. This would reduce the amount of vegetation in the reservoir and increase the overall recreational experience.

GEOLOGY, MINERALS, AND TOPOGRAPHY

Excavation of the dam foundation and abutments would change the existing topography. The excavation would be filled with the concrete of the dam's foundation, replacing the existing natural topography with a 243-foot high concrete dam.

As the reservoir is filled, geologic, mineral, and topographic features upstream of the dam and below the high-water line (6,010 feet of elevation) would be periodically inundated and lost from view. The geologic features affected are very similar to those found in a large part of the Platte Canyon and the loss is not thought to be significant. Existing data, based largely on geologic inference, indicate that the chances of discovering a minable ore deposit in the South Platte Canyon is very small. The chances of having a minable deposit in the 95 acres to be occupied by the dam and reservoir would, therefore, be even smaller. The construction and operation of the dam and appurtenant structures would, however, prevent prospecting during the life of the dam.

Shoreline erosion and landslides are possible effects of the fluctuating water levels.

The establishment of the treatment plant would not jeopardize any significant clay or limestone resources as the value of these deposits is very slight based on current economics and markets.

The seismic activity of an area has sometimes been known to increase with impoundment of large bodies of water, as a result of the increased pore pressure at depth. This pressure can cause previously inactive areas to become seismically active. This type of seismic activity is usually associated with reservoirs whose dams are over 300 feet high, but it has occurred with dams as low as 120 feet high. It is not known whether increased seismicity would result from filling the Strontia Springs Reservoir.

The river carries about 70,000 tons (36 acre-feet) of sediment past any given point annually. Based on the DWB-predicted sedimentation efficiency, 78 percent of these sediments, or 54,400 tons (21 acre-feet) per year, would probably be deposited in the relatively quiet waters of the reservoir. The sediment would be deposited below or at the water line in the upstream end of the reservoir. Some minor bars might develop, but none would protrude above the high-water line. The waters that leave the reservoir would carry only 22 percent of their former load.

If total bedload were not regained before the river reaches the existing downstream South Platte Intake, sedimentation within that diversion structure would be reduced, requiring less maintenance of the facility.

The removal of less than 6,700 cubic yards of impervious fill for use in the cofferdams from an existing 1-acre pit near Kassler should cause that borrow area to be deepened an estimated 3 feet. This should not affect the human environment to a measurable degree.

The aggregate to be used in construction of the dam would be excavated from a site within the high-water line of the newly completed Chatfield Dam on the South Platte River. About 300,000 tons of material would be used. To date, no development of these aggregate deposits has occurred. The deposits have been tested for suitability but no accurate estimate of the total reserves present has been made. The local demand is satisfied by several private sand, gravel, and aggregate producers in the vicinity. The proposed deposit is within the take line of the Chatfield Dam and heretofore has been in private ownership.

The Stevens Gulch staging area would require the leveling of 4 acres of land. The surface is characteristically open, and gently sloping; rock outcroppings are rare. The gentle slopes of the natural topographic surface would be flattened; gross changes in topographic elevation would probably be less than 25 feet.

Access road improvements would have minor effects on topography where cuts and fills would be necessary. An exception to this would be between survey stations 340 + 50 and 354 + 50, where the old railroad bed would be eliminated. The dam crest road would alter the topographic character on about 4 acres with a hillside cut.

Excavation of the proposed Foothills Tunnel would affect the removal of parts of several geologic formations; however, the impact of that operation would be negligible when compared to the broad areas occupied by the formations. This operation should not impact topographic landforms or known mineral resources; however, it would possibly expose some minor ground water aquifers in both sedimentary and metamorphic rock.

Construction and operation of the treatment plant complex would alter the existing landform in that area. Excavation and grading would alter landforms while operational buildings would alter the natural continuity of the landscape. Also, about 4,490 pounds (3 cubic yards) of sludge would be produced daily from the proposed treatment plant operation at 125 mgd; at 500 mgd, the plant would produce 28,500 pounds. This material would be dumped in to an abandoned quarry near the plant, possibly resulting in the eventual filling of this quarry and restoration of the original landform.

The trenching operation along Conduit No. 27 and the second parallel conduit would temporarily alter the topography while the 15-foot-wide, 15-foot-deep trench was open (about three months). After that, the trench would be backfilled and the natural shape of the land would not be further affected.

SOILS

Construction of the Foothills Project would result in increased sediment yields from disturbed areas during construction and the ensuing rehabilitation. Table 3-7 summarizes the increased sediment yields from various project components and traces sediment yields through the years that increased erosion would occur. Sediment yield values in the table are based on sediment yield, increasing from the present 0.5 ton per acre to 3 tons per acre. The increase of 2.5 tons per acre during the first year would decrease at a rate of 0.1 ton per acre during each of the following ten years that might be needed for rehabilitation.

New road construction and upgrading of old roads would disturb the soil on approximately 28 acres (not including the rock outcropping) in the canyon. These actions would add 70 tons (0.04 acre-feet) of sediment to the river during the first year and 385 tons (0.2 acre-feet) during ten years, the time estimated necessary for the re-establishment of a vegetation cover. The amount of sediments lost would depend upon storm intensity and the number of high runoff events during any one year. Climatalogoical data indicate there are about eleven storms annually during which precipitation exceeds 0.5 inches in one day. Most of the soil loss would probably occur

TABLE 3-7

INCREASES IN SEDIMENT YIELD (TONS) BY YEARS

Action	Acres Affected	Present Annual Sediment Yield	Sediment Yield (tons) 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	Total
Vegetative clearing	30	15	75	75	75 1/									225.0
New road and upgrading	28	14	70	63	56	49	42	35	28	21	14	7.0	0	385.0
Powerline and telephone lines	5	2.5	12.5	11.25	10.0	8.75	7.50	6.25	5.00	3.75	2.50	1.25	0	68.8
East portal	11													
Access road	3	1.5	7.5	6.0	4.50	3.00	1.50	0						22.5
Portal access staging area ponds	8	4	20.0	20.0	20.0	16.0	12.0	8.00	4.00	0				100.0
Treatment plant complex														
Treatment plant site at 125 mgd	135 2/	67.5	167.5	167.5	175.0	140.0	105.0	70.0	35.0	0				860.0
Treatment plant site at 500 mgd	90	45	112	112	117	94	70	47	23	0				575
Total	225	112.5	279.5	279.5	292	234	175	117	58	0				1435.0
Conduit No. 26 and Aurora intertie	10	5	25.0	20.0	15.0	10.0	5.0	0						75.0
Conduit No. 27	105	52.5	262.5	210.0	157.5	105	52.5	0						787.5
2nd Parallel Conduit	105	52.5	262.5	210.0	157.5	105	52.5	0						787.5 3/
													Grand Total:	3,886.3

1/ Dam will be completed after 3 years; area will be inundated or sediment will enter storage area.
2/ See text as to how construction will affect these 135 acres.
3/ This represents 2 acre-feet.

during those storms. Sediments produced from construction in the canyon would be deposited in the South Platte intake diversion. Water quality and aquatic habitat would be affected between the sediment source and the South Platte intake.

Additional impacts would result from the installation of power and telephone lines. Five acres of soil and vegetative disturbance would be required during the installation of this project feature, which would increase the sediment yield by 12.5 tons during the first year and 68.8 tons (1.036 acre-feet) during the ten years necessary to re-establish ground cover.

The clearing of vegetation below the high-water line in the reservoir area would disturb soils and vegetation on approximately 30 timbered acres. From that portion of the cleared area in the South Platte Canyon (14,800 feet of a total of 16,800 feet), about 88 percent of these sediments, or 60.5 tons, would be deposited in the South Platte River and eventually in the South Platte intake. This would affect water quality and aquatic habitat in the 2.6 miles of river above the South Platte intake within the 117 acres characterized by montane vegetation. This would result in an additional 75 tons of sediment per year being deposited in the South Platte River and eventually the South Platte intake. Since construction would require about three years, the total yield of sediment would be 225 tons (0.116 acre-feet). This would also affect water quality and aquatic habitat. After construction, the area would be inundated and thus no longer subject to erosion.

Impacts of erosion from the Stevens Gulch staging area should be insignificant because of the high permeability rate of the material that would be used in the construction of the staging area and because most of the 4 acres would be gently sloping to flat. As an added measure, a retention dam would be constructed below the staging area to intercept any sediment from the area.

Of the 30 acres to be disturbed in the east portal area only 11 acres would be subject to soil losses from surface disturbance. The remaining 19 acres, planned for spoil disposal, would have no impact because a berm and drainage ditch would be constructed around the area to channel sediment into an adjacent retention pond. Under the proposal no sediment would be allowed to enter Little Willow Creek.

Within the 11 acres that would be disturbed by construction, about 4 acres would be in the staging area and 2 acres at the portal access. Over a five-year period, 22 1/2 tons (0.012 acre-feet) of sediment would be yielded from the access road. Sediment yield is based on the assumption it would take five years to re-establish ground cover.

The portal access, staging area, and pond areas would yield 100 tons (0.052 acre-feet) of sediment over a seven-year period. Erosion would take place during construction (three years) and then during an additional five years, until a ground cover is established. Sediment from these areas would enter Little Willow Creek, which flows into the Highline Canal.

Soil and vegetation disturbance associated with construction at the 125 mgd treatment plant complex would occur on 145 acres: 10 acres for Conduit No. 26 and the Aurora intertie and 135 acres for the treatment plant. At any one time, about 50 percent of the area needed for the 125 mgd treatment plant would be disturbed and subject to erosion during the three-year construction period. This area would yield 167.5 tons of sediment annually, a total of 335 tons (0.173 acre-feet) over the three-year construction period. After construction, 65 acres of this complex would be occupied by buildings, ponds, and pavement and would not be subject to erosion. The remaining 70 acres would yield 525 (0.271 acre-feet) tons of sediment over a five-year period.

The ten acres of disturbance from Conduit No. 26 and the Aurora intertie, which are part of this complex, would yield 75 tons of sediment during the five-year re-establishment period.

Detailed site planning is not completed on the second, third, and fourth 125 mgd increments, so soil and vegetation disturbance associated with expansion to 500 mgd cannot be discussed here except in general terms. Ninety acres of soils would be disturbed between the year 1983 and 2001, yielding a total of about 575 tons of sediment. During this time, 204 acres of vegetation would be disturbed; of these, 114 acres would be permanently occupied by structures (Tables 3-7 and 3-8).

The disturbed area in the treatment plant complex for both 125 and 500 mgd levels would be 1,435 tons (0.75 acre-feet) of sediment. This area would be subject to wind erosion also but no data are available at this time to quantify this impact.

With the installation of Conduit No. 27, approximately 105 acres of soil and vegetation would be disturbed over a period of three years. About 8.5 acres would be disturbed each month, with an average lag time of three months before rehabilitation would begin to take place. Approximately 787.5 tons (0.407 acre-feet) of sediment would be yielded from the 105 acres during the five years for revegetation and the four-month lag time when the area would be constantly disturbed. Of the 787.5 tons of sediment from the pipeline, 47 tons would enter Willow Creek, 292 tons would enter Plum Creek, which flows into Chatfield Reservoir, 73 tons would flow into Spring Creek drainageway, which flows into Plum Creek, 71 tons would flow into Marcy Gulch, a tributary to the South Platte River, 180 tons would flow into Dad Clark Gulch and Clark Creeks, which flow into McClellan Reservoir, and 129 tons would flow into Little Dry and Dry Creeks.

TABLE 3-8

VEGETATION DISTURBANCE OF THE FOOTHILLS PROJECT
DURING THE LIFE OF THE PROJECT

Construction Area and Zone	Acres Disturbed Permanent	Acres Disturbed Temporary	Temporary Disturbance Time	Years Required for Revegetation	Total Acres
Reservoir	117				117
Stevens Gulch access road	5	5	(5 mos.)	10	10
Dam crest road	2	2	(5 mos.)	10	4
Dam base road	3	-	(5 mos.)	10	3
Road above reservoir	1	1	(5 mos.)	10	2
Concrete aggregate	-	150	(2 yrs.)	5	150
Stevens Gulch portal and staging area	-	4	(2 yrs.)	10	4
East portal	-	30	(2 yrs.)	5	30
Tunnel	-	-	-	-	-
Treatment plant complex					
125 mgd	65	80	(2 yrs.)	5	145
500 mgd	114	90	(2 yrs.)	5	204
Total	179	170			349
Power and telephone lines and roads	-	5	(6 mos.)	10	5
Conduit No. 27 and 2nd Parallel conduit (native vegetation)					
125 mgd	-	85	(3 mos.)	5	85
500 mgd	-	85	(3 mos.)	5	85
Total		170			170
Conduit No. 27 and 2nd Parallel conduit (cropland)					
125 mgd	-	20	(3 mos.)	1	20
500 mgd	-	20	(3 mos.)	1	20
Total		40			40
Sludge disposal	-	5	(1 yr.)	5	5
TOTAL	307	582			889
Summary by Vegetation Zones					
Riparian zone	27	5		10	32
Montane zone	101	12		10	13
Grassland zone (native)	179	525		5	704
Grassland zone (cropland)	-	40		1	40
Total acreage	307	582			889

The second parallel conduit would also disturb 105 acres of soils between the year 1983 and 2001, also yielding 787.5 tons of sediment as did Conduit No. 27. During five years for revegetation and a four-month period of continuous soil disturbance, 210 acres of vegetation would be affected but would be completly restored (Tables 3-7 and 3-8).

There would also be some minor erosion due to wind along Conduit No. 27 and the second parallel conduit, but no data are available to quantify the impacts.

Although data are not available to measure soil loss due to the project beyond ten years, the loss of 3,886 tons (2.4 acre-feet) of soil from 330 acres in the project area would probably not reduce long-term soil productivity noticeably. Vegetative re-establishment might be reduced slightly, but the effect would hardly be measurable.

TERRESTRIAL RESOURCES

Vegetation

Construction of the reservoir and ancillary facilities in the Waterton Canyon would destroy 136 acres of vegetation, 128 of which would be permanently lost to production because of reservoir clearing and permanent roads (Table 3-8). About 100 large Douglas-fir, pine, and cottonwood trees would be affected.

As noted in Table 3-8, the 582 acres of temporarily disturbed vegetation would be completely lost for periods varying from three months, in the case of Conduit No. 27, to two years, in the case of the portals and treatment plant complex. It would require about five years for disturbed areas in the grassland zone to regain near-full production and ten years for disturbances in the montane and riparian zones.

The permanent loss of 27 acres of riparian habitat would be partially offset by a gain of 14 acres of riparian vegetation that would naturally establish along the shoreline and one acre of riparian vegetation which would re-establish in Stevens Gulch in about ten years. There would be a net loss of 12 acres of riparian vegetation and ten years of habitat loss.

The net effect of vegetation disturbance on wildlife species should not be significant. The significant adverse impacts on wildlife species would occur from human harassment during construction, especially of the dam, tunnel, and roads. The entire Waterton Canyon would be adversely affected. The smaller, less mobile species such as rodents and reptiles would not be able to relocate in other areas and would be

lost because of the lack of unoccupied niches. Larger, more adaptable species such as deer, bobcats, sheep, and bear would probably shift to less intensely disturbed areas. Wildlife losses would affect aesthetic and recreation values.

After construction, most species could return to the areas which had been temporarily disturbed, as construction would result in little net loss of biomass. The return to near preconstruction conditions would depend on the amount of human use allowed in the canyon after construction. Although the canyon would be closed to recreational use during construction, present plans are to reopen the canyon afterward. The reservoir could attract additional visitors who would not use the area without the reservoir. Features such as the temporary access routes and maintenance of all features would not cause permanent adverse impacts.

The impact to wildlife as a result of the Dillon Reservoir drawdown would be minimal. The drawdown would be greatest during the winter and early spring, when the reservoir is frozen and waterfowl and raptor use is minimal.

Wildlife

Bighorn Sheep

The loss of vegetation resulting from this project would probably not impact the Bighorn sheep; however, the primary impact of constant harassment and noise associated with the construction work over a three-year period could completely drive Bighorns out of the lower sections along the stream and force them to concentrate away from the intense activity. The human harassment and noise of blasting and heavy equipment would disrupt the entire range of the Bighorn, but the sheep would probably have to remain in the canyon since surrounding areas are not only heavily impacted by humans but are also not suitable habitat.

The negative effect on the sheep would probably not be immediate, but loss of traditional lambing areas and breeding and wintering areas (Map 2-7) could reduce the herd's lamb crop, as was speculated by Jones and Jones (1974) (Appendix) to have happened during construction of the Waterton Canyon intake in the 1960s. Harassment could cause changes in behavior, including interruption or discontinuance of breeding habits, and therefore affect reproduction and recruitment. More recent data, cited in Chapter 2, indicate that disease caused by crowding and stress may be an even more serious decimating factor. The incidence of lungworm-induced pneumonia increases with crowding; however losses from the disease may be delayed for several years.

The impact on the sheep herd from all sources could result in a 50 percent herd reduction in Waterton Canyon. The entire 60- to 65-head

could be lost as a result of this project, but it is more probable that the herd would be reduced to 30-head. Loss of Bighorns would adversely affect recreation and aesthetic values in the Waterton Canyon.

Endangered Species

Peregrine Falcon

Disturbance of the riparian habitat along the North Fork as a result of higher flows could reduce the peregrine's essential feeding area enough to cause abandonment of the existing nesting site by the pair. In addition, the constant human activity during construction would preclude possible use of the Waterton Canyon by feeding peregrines. No known nesting sites would be impacted by the construction phase of the project.

Southern Bald Eagle

The impact on the southern bald eagle cannot be quantified.

Other Animal Species

Golden Eagle

If initial road construction in the Platte Canyon were to begin in March or April, as indicated in Figure 1-3, it is probable that one golden eagle eyrie with eggs and/or young would be deserted. The net result would be the loss of that nesting cycle for one year for one pair of eagles. If the nesting cycle were successful, one or two young would probably be reared. The eagles would probably nest in unoccupied eyries away from the disturbance during the next two construction seasons and reoccupy the sites soon after construction ceased. However, due to the large number of people using the area now, the eagles are accustomed to the people pressure and would probably continue to use these nesting sites. Golden eagles, as well as other birds of prey, would eventually benefit from the prey species attracted to the reservoir and treatment plant area.

Deer and Other Big Game

Deer, mountain lion, and black bear would be disturbed and driven from the South Platte Canyon and Stevens Gulch by construction activity. Also, illegal killing of these animals would take place.

Construction of each of the two segments of Conduit No. 27 and the second parallel conduit would temporarily disturb 85 acres of grassland vegetation and 20 acres of cropland, bisect two prairie dog colonies, and possibly temporarily dislodge antelope from part of 3,000 acres (approximately 8 percent) of their range north and west of the conduit near the Highlands Ranch (Map 2-7) for about ten months. The impact

on these species would be very slight and temporary. The few prairie dog burrows which would actually be excavated (approximately 100) would be less than 0.1 percent of the burrows in the general area. As evidenced in the recently disturbed area along the Aurora pipeline, prairie dogs would return to the disturbed area, possibly in increased numbers, after the three-month disturbance.

Raptors and other birds could be injured or killed by electrocution or by flying into the power lines. Proper design will prevent electrocution, but nothing will prevent them from flying into the lines.

CLIMATE AND AIR QUALITY

Construction and operation of the proposed Foothills Project would not measurably change the climate of the Foothills area. Construction activities could yield several types of air pollution: dust from earth-moving operation, dust from unpaved roads, and emissions from earth-moving vehicles and trucks. These are direct, short-term impacts that would affect the Foothills area for about 30 months. Air quality would not be measurably decreased as a result of the operation and maintenance of any aspect of the proposed project.

On the unpaved access roads dust created by vehicles hauling concrete aggregate would occur primarily during April through September for two consecutive construction seasons. An estimated twenty truckloads of concrete aggregate per day would be hauled to the dam site during that period. Typically, concrete aggregate would be hauled to the dam site during the daylight hours. Estimates are that the net effect of dust from hauling and earth moving would increase over the ambient air quality levels in the primary impact zone by less than 10 percent. The effects outside the primary impact zone would not increase enough so they could be measured.

Use of construction vehicles would result in emissions. However, the Clean Air Act of 1970 requires emission control devices on all new vehicles, including construction vehicles. Because of the increased number of vehicles in the area, emission would increase during peak construction activities (six months for each two consecutive seasons). This increase in emissions is not expected to reach levels that would be hazardous to human health or measurably affect vegetation in the primary impact zone.

The production of ozone from any proposed power lines could become an environmental problem if voltages exceed 345 kilovolts. The low voltage transmission and power lines on this project (13.2 kilovolts) would not result in ozone production that affects plants, animals, or man.

Slight increase in fugitive dust from construction activities of Conduit No. 26 and the proposed treatment plant could not be measured. Effects of the proposed laying of Conduit No. 27 and the additional conduit necessary for the treatment plant to operate at 500 mgd would be identical.

If chlorine were accidentally spilled, the chlorine, a heavy greenish-yellow irritating gas with a pungent odor, would vaporize and, being heavier than air, concentrate next to the ground. The gas would drift with the wind or would flow down slope like water and concentrate in low areas. Since the prevailing winds and drainage systems move from south to north, air quality conditions would be seriously degraded in the southern Denver metro area and emergency measures, including evacuation of residents from the affected area, would have to be implemented to prevent injury and illness. The number of injuries occurring as a result cannot be quantified.

Accidents resulting in spilled ammonia, a pungent colorless gas, would introduce an irritating odor into the air in the vicinity of the spill. However, since ammonia is lighter than air it would rapidly mix and dilute in the atmosphere. Workers and residents in the vicinity of the spill and downwind from it might have to be evacuated from the affected area to avoid injury.

The impacts of spilled toxic chemical gases would be magnified to an unknown extent if the accident occurred during an inversion. Under inversion conditions gases would be trapped and concentrated. The resulting impacts on residents of the area would be extended until the inversion broke up and the toxic gases escaped to or mixed with the atmosphere.

NOISE

Construction within the canyon would raise noise levels to the range of 80 to 90 dBA (decibels, adjusted) at 50 feet from the equipment. Blasting, drilling, and earth moving required for the construction of these portions of the project would create a disturbance in the canyon and foothills, which now have ambient noise levels ranging from 32 to 60 dBA. These machines and their approximate sound-generation levels are listed in Table 3-10. Figure 3-4 depicts noise contours for all phases of construction.

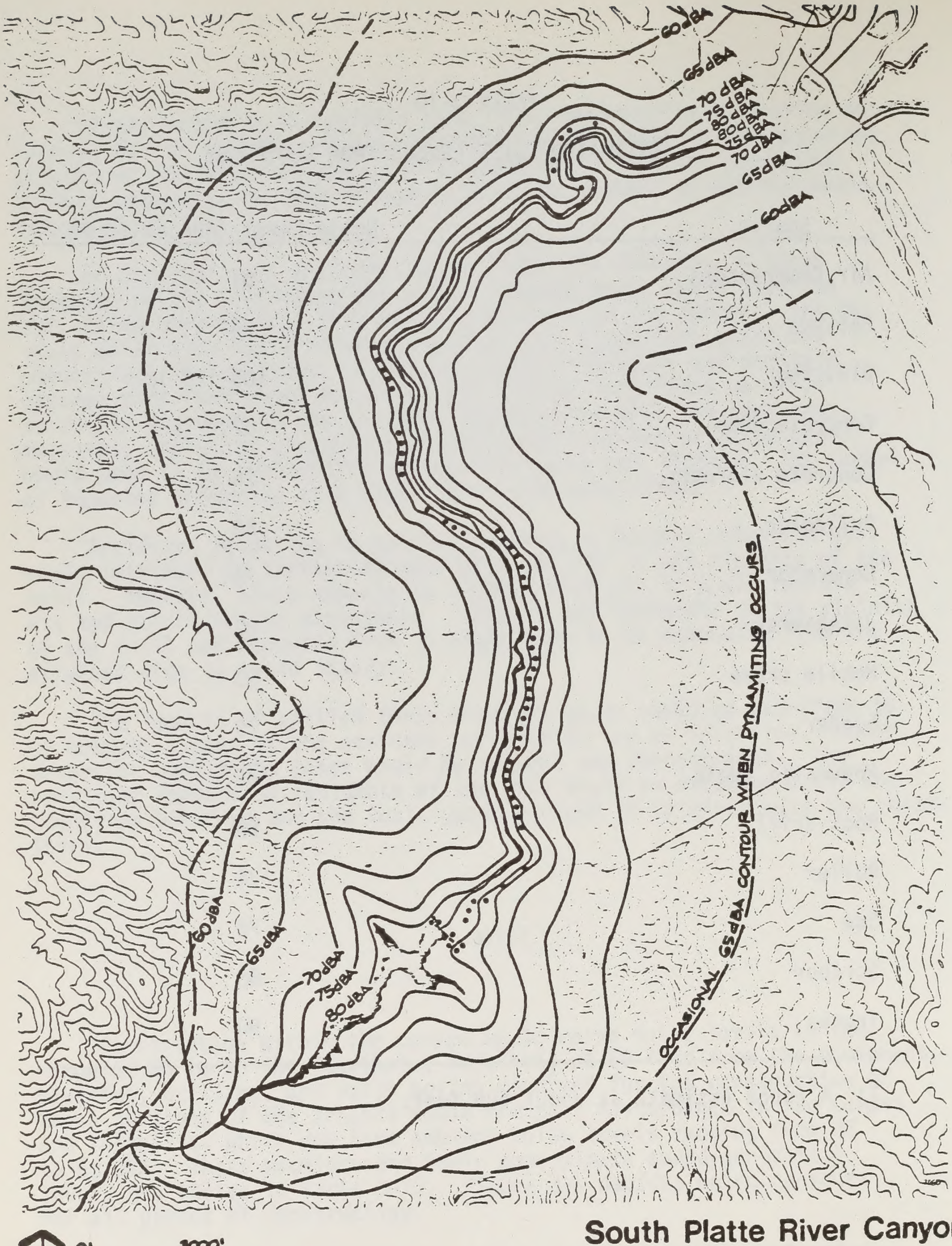
Traffic to the construction area would create additional noise in the canyon and around the Kassler Treatment Plant. Road-building equipment, trucks, and buses would generate noise during the three years of construction. Because workers would arrive at the Kassler

TABLE 3-10

ESTIMATED NOISE LEVELS FROM EQUIPMENT

Source	Noise Level (dBA at 50 ft.)
Air Compressors	81
Backhoe	85
Blasting	105-125 1/
Concrete pump	82
Concrete vibrator	76
Bulldozer	80
Generator	78
Jackhammer	88
Mobile crane	83
Loader	79
Pneumatic tools	85
Rock drill	98
Roller	74
Saw	78
Scraper	88
Trucks	90

1/ A rough estimate at about 500 feet.



South Platte River Canyon

NOISE CONTOURS

2 Year Construction Period

FIGURE 3-4

parking area in three shifts, this noise would not be confined to normal working hours.

The Stevens Gulch staging area would be noisy. If the contractor elects to mix concrete at the staging area, this process, together with the sound of trucks delivering aggregate plus the general noise generated by the construction of the dam, would raise the ambient sound level at this location to about 85 dBA. The resulting noise levels within the canyon would harass and to some degree displace, at least temporarily, many of the wildlife species found near the canyon bottom. Outside the immediate canyon the effects of the noise would be negligible.

Blasting would be required for construction of the access road. Although it is not known to what extent sudden, loud noise affects wildlife, the birds and animals in the canyon and foothills probably would be adversely affected by the blasting. Some of this noise would also be audible to people in the Kassler Treatment Plant area and possibly at Roxborough Park. Although blasting would be periodic and infrequent, it would reach an estimated 105 to 125 dBA at the source (DWB 1974).

Although much of the equipment listed in Table 3-10 would not be operated simultaneously, sound levels could reach about 90 dBA during construction. This would be perceived as eight times louder than the existing sound level (DWB 1974).

Noise levels at the treatment plant would be higher than today. There would be many sources of noise at the proposed water treatment plant, generating levels much higher than the existing ambient levels. The sources are enumerated in Table 3-11.

Most of the equipment employed in the treatment plant operation would be housed in concrete structures. The noise levels transmitted to the property line from this equipment, operating indoors, would reach only 40 dBA, about the same as the present ambient level.

After completion of the dam and reservoir, the sound level in the reservoir area would be reduced from present levels. A tranquil pool would replace the rushing river upstream of Strontia Springs. The dam would buffer the sound of regulating valves. Estimates are that the ambient sound level near the water in this area would be reduced from 60 to 50 dBA.

Sound produced by discharge from the dam's regulating valves would be continuously loud. Levels ranging from 85 to 95 dBA would exist next to the dam; 4,000 feet downstream levels would diminish to 60 dBA. Because the dam would block much of the noise, the level 40 feet upstream would be only 60 dBA (DWB 1974). Although this noise would adversely affect recreational use near the dam, it would not have a significant impact downstream from Stevens Gulch.

TABLE 3-11

SOURCES AND PROBABLE LEVELS OF NOISE AT PROPOSED FOOTHILLS TREATMENT PLANT

Sources	Noise Level (dBA at 3 ft.)
Energy dissipation valves	85
Rapid mix drives	83
Washwater pumps	92
Boilers	86
Exhaust fans	82
Engine generators	96
Overhead cranes	83
Flocculator drives	78
Sludge collector drives	78
Chemical feeders	78
Filter surface wash pumps	86
Plant service water pumps	83
Chemical mixers	78
Air compressors	95
Air conditioning unit	89
Personnel vehicles	65 1/
Delivery trucks	85 1/

DWB 1974.

1/ At 50 feet.

Construction of Conduit No. 26, the power generation and treatment plant would create higher sound levels than exist today. The equipment used in construction of the proposed water treatment plant is similar to that used in the canyon. The noise levels generated by this machinery range from 85 to 95 dBA at a distance of 50 feet. The Roxborough Park community would probably receive levels of about 50 dBA. Construction noise would vary over the building period. The noise levels would probably have little or no effect on the wildlife or human populations in the immediate vicinity. The 50 dBA noise level in Roxborough Park would be hardly noticeable.

As a result of workers and equipment using surrounding roads for access to the plant site, traffic might increase on adjacent roadways now lightly traveled. Some additional traffic noise thus would be generated in the surrounding community (DWB 1974). These impacts are not considered significant.

Noisy equipment would be used in laying Conduit No. 27 and the second parallel conduit. The backhoe, bulldozers, and scraper equipment used in construction would generate noise levels of 80 to 85 dBA. This sound level is considerably higher than existing levels.

Some temporary disturbance would result in the developed residential areas, but, owing to the relatively short time involved in any one location (work would progress at about 115 feet per day) and the presence of other similar activities, the impacts would not be significant.

Noise levels associated with power generation when the plant is operating at both 125 mgd and 500 mgd levels are unquantifiable but are considered insignificant because power generation facilities are encased in concrete structures and are below ground level.

VISUAL RESOURCES

Due to the proposed closure of the Platte Canyon during construction, only the short-term visual impacts resulting from construction of the water treatment facility and conduits would be realized. Because of this, the discussion of short-term impacts will be limited to those features.

The visual impacts of a proposal on an area can be measured by their relative contrast with the existing landscape. The contrast would vary with the specific elements of the proposal, the specific locations of those elements, and the existing landscape as described by physical attributes, including integrity, a descriptive term referring to the degree of discordant or unsightly features within the landscape.

Contrast is assessed in terms of how the proposal is expected to affect existing physical attributes - landform, vegetative patterns, and existing structures such as power lines and buildings. Anticipated changes in form, line, color, and texture are analyzed individually in reference to landform, vegetative patterns, and structures. The resulting contrast ratings are compared to the maximum contrast limit for the particular visual management class indicated for the land affected by the proposal (see Maps 2-8, 2-9, 2-10, and 2-11).

As indicated in Tables 3-12 and 3-13, the specific elements resulting in visual contrasts are: inundation and increased stream flows, the Strontia Dam, the 22-foot standard dam access road, the 22-foot standard road widening, the 12-foot standard road widening, Stevens Gulch staging area, the power and telephone lines to the damsite, the water treatment facility, and Conduit No. 27 and the second conduit parallel to it. A description of visual contrast generated by each element follows.

Inundation and Increased Stream Flows

Inundation in the Waterton Canyon behind the Strontia Springs Dam would radically change the landscape. Instead of a narrow, steep-walled, rocky canyon with the South Platte River dominating the landscape, there would be a placid lake with steep, rocky hills along its shoreline. The strong sense of enclosure would be relatively unchanged at the west end of the reservoir but greatly diminished near the damsite.

Although this would constitute a radical change, the resulting landscape would also be pleasing to the eye. The anticipated drawdown is so small that it should not significantly affect the visual integrity of the proposed shoreline.

Increased flows in the North Fork of the South Platte River would not have a significant visual impact on the landform unless significant stream bank erosion occurs (Figure 3-6). The degree of bank erosion that must occur before resulting in a significant impact would vary with the situation. For example, a 5-foot high eroding bank may be significant within 100 feet of the associated sensitive feature and not significant 300 feet away. As a result, this impact is impossible to quantify in more than general terms.

The character of the river would be changed by raising the sustained flow. The unchannelized portion of the North Fork of the South Platte River would become a faster, more massive river during July, August, and September than has been seen in the past during the same time period (Figures 2-1 and 2-2). The varied shades of blue, green, and brown produced by the combined water depth, flow rate, and channel characteristics of the river would be changed by the increased water flows. The resulting

TABLE 3-12

ANTICIPATED VISUAL IMPACTS
DURING CONSTRUCTION PHASES

Rated Element	Anticipated Visual Contrasts			Visual Management Class Maximum Contrast Limit
	Landform	Vegetative Patterns	Structures	
Water Treatment Facility	23	18	27	24
Conduit No. 27	22	20	18	24
2nd Parallel Conduit	22	20	18	24

TABLE 3-13

ANTICIPATED VISUAL IMPACTS AT YEAR 2001

Rated Element	Anticipated Visual Contrasts: Landform	Vegetative Patterns	Structure	Visual Management Class Maximum Contrast Limit
Inundation and Increased Stream Flows	7-13 1/	12	NA	16 2/
Strontia Dam	30	NA	30	16
22-foot Standard Dam Crest Road	17	20	NA	16
22-foot Standard Road Widening	25	18	NA	16
12-foot Standard Road Widening	23	NA	NA	16
Stevens Gulch Staging Area	17	10	21	16
Power and Telephone Lines to Strontia Dam Site 3/	6	7	22	16
Water Treatment Facility	12	27	25	20
Conduit No. 27	13	10	7	20
Increased Annual Drawdown of Dillow Reservoir	10	27	NA	10
Second Parallel Conduit	13	10	7	20

1/ Higher figure assumes bank erosion.

2/ This would be a rating of 20 in Class IV areas. See Maps 2-8, 2-9, 2-10, and 2-11.

3/ Assuming a line constructed with minimum clearing and no mechanized leveling.

Figure 3-6. Stream bank erosion presently occurring on the North Fork of the South Platte River.

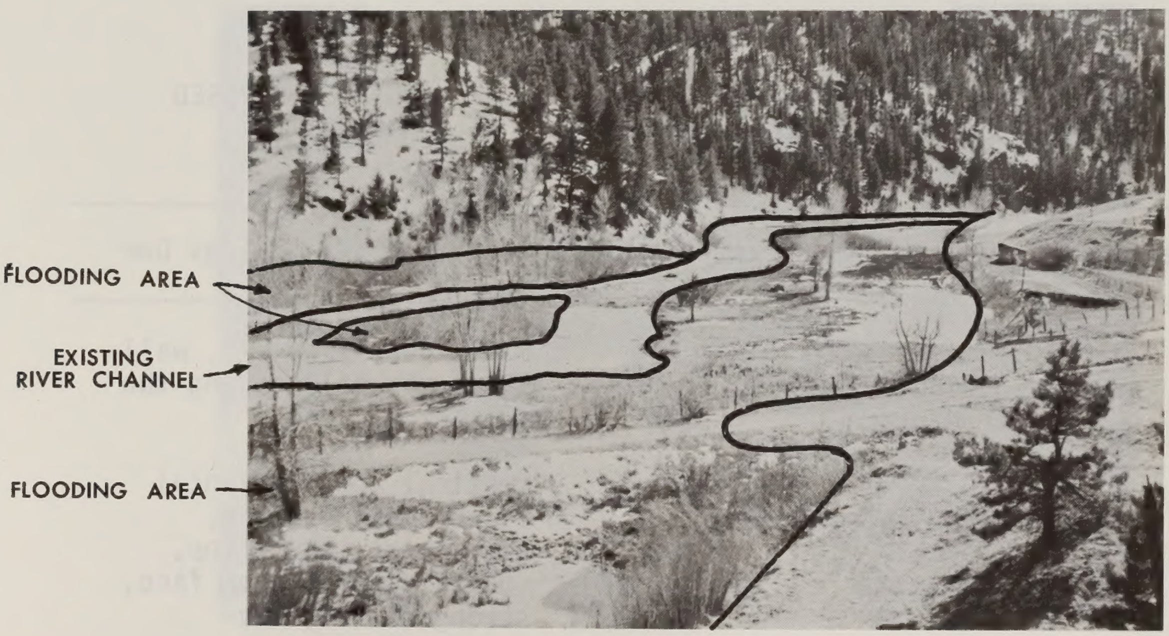


Figure 3-7. Bottom lands subject to temporary flooding during periods of peak river flow.

colors would be mainly shades of blue and green, with little brown remaining. As a result, the visual and photographic variety of the river would be reduced. Periods of river flooding resulting from peak demand flows and sudden runoff from precipitation would intensify this impact. Figures 3-7 and 3-8 show areas expected to be flooded during peak flow periods.

Increased annual drawdown of Dillon Reservoir would produce large mud flats between the shoreline vegetation and developments and the reservoir pool. Since drawdown, anticipated to be about 44 feet, would occur in the summer and fall, visual impacts would be large, greatly exceeding the visual management class limits (Table 3-13).

Strontia Springs Dam

This part of the proposed action would impose a massive manmade feature on a relatively undisturbed landscape. As is illustrated by Figure 3-9, the dam would abruptly end the linear continuity of Waterton Canyon. It would dominate the landscape at that point due to its size and location.

The dam would produce high contrasts with the existing landscape in terms of landform, line, color, and texture, (the four basic elements used by the BLM to determine contrasts between proposed changes and the existing landscape.) Table 3-14 shows a comparison of the physical characteristics of the existing landscape and the proposed dam.

TABLE 3-14

VISUAL COMPARISON OF THE EXISTING LANDSCAPE AND THE PROPOSED STRONTIA SPRINGS DAM IN TERMS OF LANDFORM

Element	Existing	Strontia Springs Dam
Form	Jagged, blocky, enclosed corridor effect is strong	Flat, gently curved, wall-like, abruptly ending the visual corridor
Line	Angular with very strong convergence, broken ridgeline	Vertical and horizontal linear grid on face, horizontal linear top, smooth concavity on face, strong convergence
Color	Dark grey, black, green, red-brown	Light gray
Texture	Coarse	Smooth

Figure 3-8. Bottom lands subject to temporary flooding during periods of peak river flow.

Figure 3-9. Site of the proposed Strontia Springs Dam.

The contrasts shown in Table 3-14 are evident at Cheesman Dam (Figure 3-10). Although more vegetation is present and the face of Cheesman Dam is stone masonry, the impact would be similar.

Although the Strontia Springs Dam would generate a visual contrast generally considered to be too high by BLM standards (Table 3-13), such a structure is both graceful and impressive. Its construction still, however, would destroy the natural landscape within its view.

Dam Crest Road

This road would not be entirely visible from the floor of Waterton Canyon or the surface of the reservoir. It would be plainly visible, however, where it enters the visual corridor. At that point it would be a linear, cleared scar traversing a timbered, steep slope on a prominent part of the canyon wall (Figure 3-11). Because the road is above the point of observation, the road bed itself would not be visible.

Road Widening

The existing access road is the feature in Waterton Canyon from which visual impacts of the proposal would be viewed. Because of this, modifications of the existing road that create visual impacts would be very evident and are likely to dominate in the foreground. As shown in Figure 3-12, a road built with a 22-foot driving surface and its associated cut into the rocky canyon wall would result in high impacts on the landform in terms of form and color and moderate impacts on line, created by both the rock and soil cuts and the significantly larger road. The anticipated impacts of the road widening proposals are shown in Table 3-13. Examples of the existing road proposed for widening are shown in Figure 3-13 and can be compared with the existing 22-foot standard road shown in Figure 3-12.

Staging Area

The landscape resulting from construction of the staging area would be quite different from the existing conditions (Figure 3-14). When viewed from the existing road in the Platte Canyon, the finished staging area would produce impacts similar to those discussed for the Strontia Springs Dam. Several factors reduce the impact of the staging area compared to that of the Strontia Springs Dam. The retaining wall/tunnel access structure is considerably smaller than the Strontia Springs Dam.

Figure 3-10. Cheesman Dam: example of a dam structure located within scenery comparable to that of Waterton Canyon.

Figure 3-11. Rocky point that would be traversed by the proposed dam crest road.

Figure 3-12. Existing access road constructed to a 22-foot standard in Waterton Canyon.

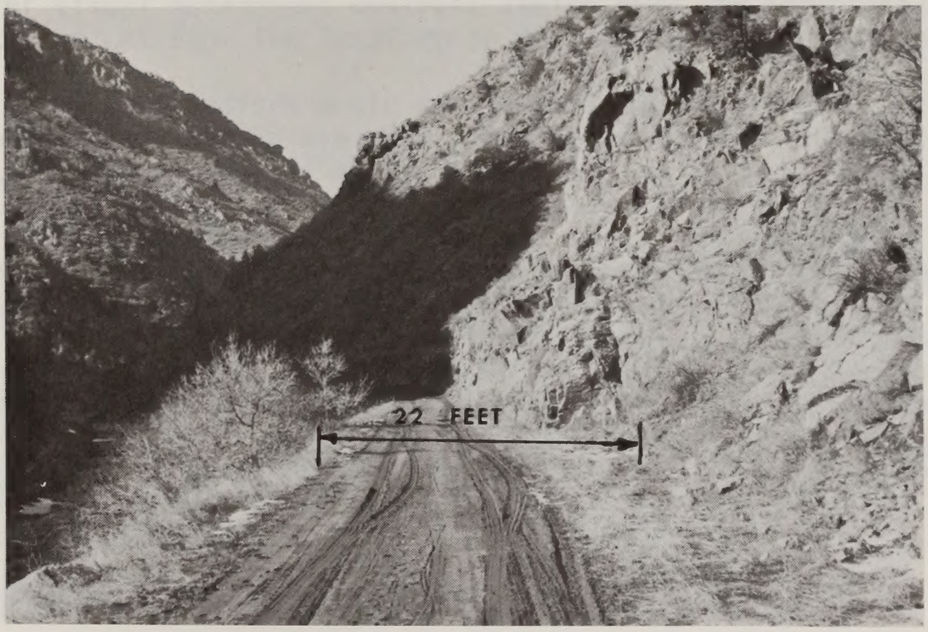


Figure 3-13. Segment of road proposed for widening to a 22-foot standard. The existing road is 10 to 12 feet wide.

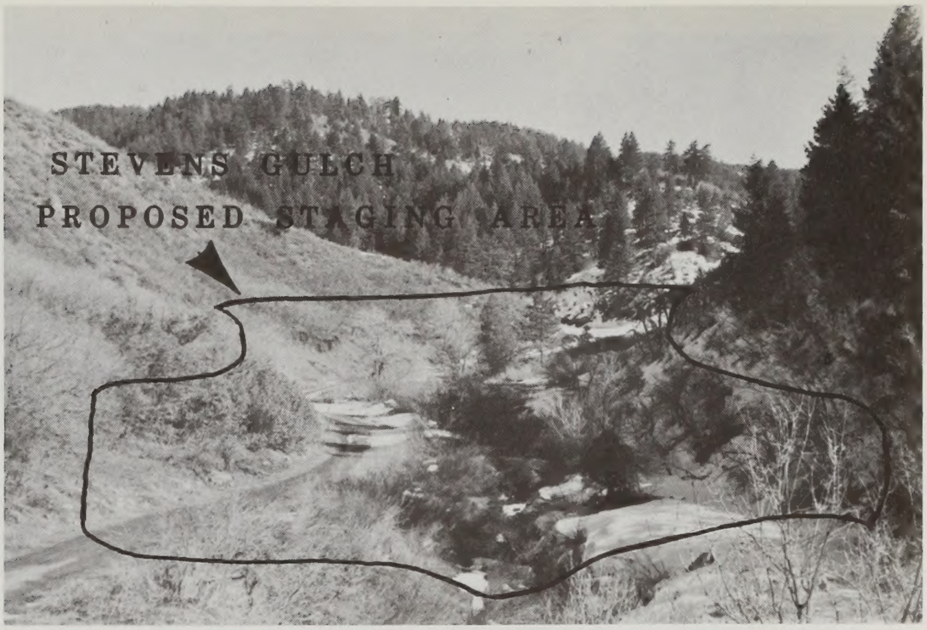


Figure 3-14. Stevens Gulch at the site of the proposed staging area.

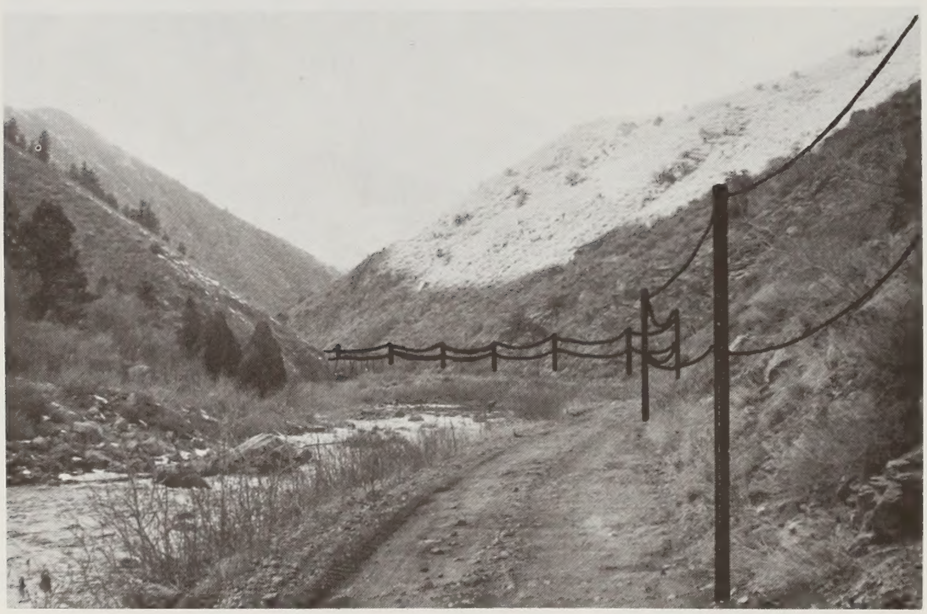


Figure 3-15. Segment of Waterton Canyon included in the proposed power and telephone line route.

Stevens Gulch at the proposed staging area site does not have the near-vertical side-slopes found in Waterton Canyon. The texture of the landform is more compatible with that of the proposed staging area. The staging area would be overshadowed by the visual impact of the dam.

Power and Telephone Lines

Construction of a combined power and telephone line to the damsite would generate high visual impacts from the structural standpoint (Table 3-13). This impact would be mainly caused by the imposition of a structure with strong linear characteristics on a landscape that has no such structure presently visible (Figure 3-15). The impact on the linear characteristics of the Waterton Canyon as well as contrasts in color would be intensified if reflective wire were used.

Foothills Treatment Plant

Construction of the treatment plant would radically change the existing landscape. The general impact would be the conversion of a presently undeveloped, sloping tract of land, shown in Figure 2-4, to a partially leveled tract covered with structures, asphalt, and formal landscaping (Figure 1-11). As indicated in Table 3-12, the visual contrast levels anticipated to occur during construction would be in excess of visual management contrast limits from the structural standpoint, but not from the landform or vegetative pattern standpoint.

The impacts on landform would mainly be in terms of form. Extensive leveling would occur in the area where buildings would be constructed. However, the present landform is relatively flat with gently rolling terrain, so the contrast is considered moderate rather than high.

As shown on Table 3-13, long term visual contrasts concerning vegetative patterns would exceed visual management class limits. This is due to the addition of shapes foreign to the vegetative patterns in the form of structures, asphalt covered areas, and form landscaping. In addition to the shape of the formal landscaping, the grass, shrubbery, and trees are completely out of character for the existing landscape (Figures 1-11 and 2-4). Since no other formal landscaping is within view of the plant site and no trees are found on or near the site (on the plains physiographic area) the contrast would be high.

Conduit No. 27 and Second Parallel Conduit

As indicated on Tables 3-12 and 3-13, this part of the proposal would not produce excessively high visual impacts. Sensitivity of the area is low because of the number of existing intrusions, the Aurora Conduit and Conduit No. 85, suburbs, railroads, and a highway. Because of this, the anticipated impacts of both conduits are relatively low.

CULTURAL RESOURCES

Archaeological Resources

The impact on archaeological resources, both known and possible, is considered significant for several reasons. First, indications are that the plains portion of the proposed project area may quite possibly have many sites. Second, archaeological sites are fragile, non-renewable resources which are rapidly dwindling in number; therefore, virtually any identified impact is of a significant nature. Last, there is evidence of Paleo-Indian sites in the area, perhaps the rarest kinds of sites in American archaeology.

No archaeological sites have been identified in upstream areas of potential flooding, at the damsite, impoundment, access route, or staging areas; therefore, no impacts from construction or operation activities are predicted in these areas. There is, however, always potential for impact upon resources which are currently buried and unidentified.

Construction of the 1,700-foot-long Conduit No. 26 and, particularly, the treatment plant could have extensive impact on archaeological resources. The lithic material occurring generally over the plant site area would be destroyed, removed, scattered, or buried. This material has been noted by the Colorado State archaeologist as containing two significant archaeological sites and may possibly contain some significant archaeological resources as yet unidentified.

From the surface evidence, the route of Conduit No. 27 and the second parallel conduit may have considerable potential for archaeological sites. These would be damaged or destroyed during trenching for the conduit or blading of the parallel access and maintenance road.

Historical Resources

Impacts caused by the proposed action would fall into two categories, total loss of sites through the project and minor, secondary losses.

Sites that would be directly affected by the proposed project follow.

DSP&P Railbed (in Waterton Canyon). This site would be inundated by the proposed dam. About 1.17 miles of rail alignment would be permanently lost.

Deansbury Station and Strontia Springs. This site, which is in ruins, would be lost through inundation by the proposed damsite.

Telegraph Poles. These sites would be lost on a selective basis. The loss may occur through flooding caused by the proposed damsite, and there may be some loss through destruction with the improvements made on the road.

Railway Bridge (Deansbury Bridge). This site would be lost through inundation and/or removal by the project, depending on DWB needs.

Keystone Bridge. This site, eligible for the National Register of Historic Places, would be lost either through removal, destruction, modification, or site degradation, depending on the final design needs of the applicant. The integrity (visual and historic) would be lost regardless of the alternatives for disposition.

Denver and Rio Grande Railbed. This site would, by and large, be lost through inundation of the area by the proposed project.

Several sites may be impacted on a lesser level by the proposed project. These sites are in the general area of the North Fork of the South Platte Historic District and may be impacted by flooding and/or bank erosion when up to 1,000 cfs of water are moved from Roberts Tunnel to the Strontia Springs Dam, as proposed by the applicant for operation at the treatment plant at the 500 mgd level. Impacts occurring as a result would be secondary and would generally occur on an intermittent basis, as the DWB operates its system to meet peak demands. These impacts would not occur at 125 mgd.

A list of sites that may be impacted by increased flows follows. These sites are on the National Register of Historic Places and thus are under Section 106 (36 CFR 800.8 and 800.9) protection and must undergo the preparation of a 106/2b statement of impact (and mitigation) for each site that may be impacted. The statement must be prepared at the time of the ES 940 (CFR Part 1500, CEQ Guidelines) by a qualified professional historian.

Site Number FH-001. Westall Monument. Possible flooding and bank erosion would further deteriorate the base of the monument, causing collapse into the channel.

Site Number FH-007. Longview, Colorado. Possible flooding along the river would cause inundation of several buildings. This would be a temporary impact that would cause minor damage.

Site Number FH-008. Dome Rock, Colorado. This site may be subject to flooding along the low lying riverbank, causing temporary minor damage to three or four buildings along the river.

Site Number FH-011. Foxton, Colorado. This site may be partly submerged by increased flow. The site may suffer some bank erosion.

Site Number FH-012. DSP&P Abutments at Buffalo Creek. This site may be inundated on a temporary basis with increased flows. The site may suffer bank erosion which may lead to collapse with increased flow.

Site Number FH-014. DSP&P Railbed. This site will be partly flooded and the erosion caused will bring about some undermining of the embankment.

Site Number FH-017. Pavilions. This site may be inundated and/or washed out by increased flows on the river (channel).

Site Number FH-018. DSP&P Bridge. This site may be washed out from increased flows causing water pressures against the pilings, which in turn may cause erosion and the weakening of the structure.

These last two sites are not currently on the National Register but may be eligible.

Consultation for preparation of mitigation on all impacted Historical and Archaeological sites described above and as outlined in Chapter 4 has been initiated with the Colorado State Historic Preservation Officer and the Advisory Council on Historic Preservation.

Paleontological Resources

Excavations at the treatment plant site and along Conduits No. 26, 27, and the second parallel conduit could potentially encounter fossils and other materials of paleontological interest. Excavation activities would probably damage or displace fossils located in the 15-foot wide trench for Conduits No. 26 and 27 and the second parallel conduit and on approximately 204 acres at the treatment plant site.

RECREATION RESOURCES

Construction activities associated with the dam and the reservoir would alter or permanently destroy many of the canyon's unique and impressive natural characteristics sought out by recreationists. The

scenic values described in the discussion of aesthetics are an important part of the recreation opportunities associated with the canyon.

Removal of vegetation in the reservoir area and subsequent filling of the reservoir would affect recreational activities. In particular, habitats for wildlife would be lost and both numbers and species would be decreased, including Bighorn sheep. This would have an effect on the enjoyment of such activities as nature study, photography, bird watching, sightseeing, walking for pleasure, and hiking.

For safety reasons, the canyon would be closed to all recreation activity during the construction period, probably for about three years. This would be a loss of at least 30,000 recreational visits (estimated 10,000 in 1976). These losses would be expected to be absorbed by other recreational resources along the eastern foothills of the front range.

The presence of construction workers and noise associated with construction activity probably would cause those animals and birds that require solitude, especially Bighorn sheep and eagles to move out of the general area. The quality of any subsequent recreational experiences would then be diminished to the degree that wildlife did not return to the area after completion of the construction. Overall, the project is expected to result in a loss of 50 to 100 percent of the Bighorn sheep herd.

Building the dam and filling the reservoir would cause the loss of the remnant features of the narrow gage railroad and end any future consideration of its restoration for tourism and recreation purposes.

A number of impacts on the recreation resource would follow once the dam and reservoir were in place. First, the dam would present a permanent imposing barrier to recreational traffic through the canyon. Recreationists would have to leave the canyon bottom and traverse the side slopes above the dam and reservoir. Through bicycle traffic would be eliminated.

Filling the reservoir would eliminate 1.7 miles of stream that now provide high-quality trout fishing opportunities. These opportunities would be replaced with bank fishing on the reservoir. Even though the DWB plans to maintain a relatively constant pool level, the quality of the fishery habitat would be reduced by a rapid water exchange in the reservoir. The present brown trout fishery would be converted to one dominated by non-game fish. This would not necessarily mean a loss of total fishing opportunity, but it would mean a change in value.

The general setting for enjoyment of recreation activities would be transformed from the present one of relatively natural remoteness, enhanced by the rushing stream, into one dominated by a placid reservoir surface. At least initially, the dam and reservoir would be a curiosity that might attract a larger number of people than now frequent the area. Unless carefully controlled, this would certainly bring about a decrease in opportunities for solitude, an increase in littering and trampling, and possibly a loss of those species of wildlife that cannot abide frequent contact with humans.

These impacts would occur at random in areas near the reservoir, since no trails are planned to assist in control. These impacts would extend along the access road for the length of the canyon, in both directions from the reservoir. However, since there is closer vehicle access upstream, probably more than half of the visitors would use that part of the reservoir.

Widening and surfacing of the remaining unimproved portion of the access road would temporarily add to the stream's turbidity, eliminate the important streamside fish and wildlife habitat and, on the landward side of the road, further decrease the natural appearance of bordering slopes. Any of these things would lower the quality of subsequent recreation experiences.

The extent to which power and telephone lines would detract from the natural setting and enjoyment of the canyon would depend on their alignment and design. The greatest distraction to recreationists would occur where the lines and poles are easily visible from the canyon floor.

Treatment plant construction activity would disrupt the presently unbroken landscape and diminish the present attraction of the area for occasional sightseeing and driving for pleasure. Moreover, the quality of recreation experiences in the future Roxborough State Park would be decreased by greater numbers of people, traffic, and noises associated with construction. Once constructed, the treatment plant would begin to break the relatively natural setting east of Roxborough State Park. As other future intensive developments encroach on the area, the impact of the plant and associated power-generation activities would become less and less obtrusive.

Disrupting the unbroken, rolling grassland during construction of Conduit No. 27 for operation of the plant at 125 mgd and the second parallel conduit for operation of the plant at 500 mgd would temporarily diminish the quality of occasional sightseeing and driving for pleasure, now the most common forms of recreation in the area. Once laid, Conduit No. 27, the second parallel conduit, and the access road would cause no

further impacts to the recreation resources of the area. The conduits would produce a linear area generally unsuited for further surface construction. This would create an open space that would have potential for limited recreational opportunities.

Assuming that flow schedules in the upper South Platte would remain the same, upstream impacts on recreational resources would be concentrated on the river's North Fork up to Roberts Tunnel. In the North Fork with the treatment plant operational at 500 mgd, increased flows would diminish the river's use as a recreation resource to an unquantifiable degree.

As additional waters diverted from Dillon Reservoir through Roberts Tunnel increase, the annual drawdown of the reservoir at 500 mgd would reach about 44 feet, creating large mud flats that would hinder boat launching and fishing access. How much this would reduce recreation use cannot be quantified.

LAND USE

If approved, the right-of-way for the dam and reservoir in the South Platte Canyon would be senior rights against any subsequently authorized on public (BLM) and national forest lands. The dam and reservoir would require virtually all of the rights associated with the surface and mineral estate. The action could preclude the granting of any additional use authorizations and would further preclude construction of a water storage or hydroelectric reservoir at this site. In total, the dam and reservoir would commit approximately 38 acres of Federal lands to this single, primary use. Of the 38 Federal acres that would be in the right-of-way, 31 acres would be disturbed during construction. After project completion about 25 would be occupied by the dam and reservoir. The proposed project would disrupt present and probable future land uses to varying degrees. Strontia Springs Dam and Reservoir would permanently dedicate 117 acres from present uses to specific use for municipal and industrial water diversion.

Roads would occupy an additional 9 acres of forest and woodland in both the present and future, of which about 7 acres would be federally managed. Another 8 acres (seven Federal acres) of forest and woodland would be disturbed by road construction; the disturbance would last for about ten years. Four acres of private land in the Stevens Gulch area would be used for construction purposes for about three years and would require another ten years to regain their original productivity for forest and woodland use. Five acres (about two Federal acres) of forest and woodland area would be disrupted by power and telephone lines but less than 1 acre would be permanently committed over the life of the project. Table 1-1 and 1-2 detail the acreages of Federal lands that would be directly affected by the project.

The proposed facilities in the South Platte Canyon would restrict traffic to that associated with their construction during a three-year period. This would limit the multiple uses of the canyon to those not associated with public use.

Thirty acres of grazing land around the east portal and staging area would be used for construction purposes for about three years. Construction of the treatment plant facility at the initial 125 mgd capacity would disturb 135 acres for a three-year period. Of this, 65 acres would be permanently occupied by structures and lost to other uses. Security fencing around the facilities would enclose about 255 acres and effectively close them to uses other than open space. Addition of incremental plant units between 1983 and 2001, such as flocculation and sedimentation beds, clear water reservoirs, and sludge drying beds, to attain 500 mgd capacity would eventually occupy an additional 49 acres within this fenced area, with temporary disturbance of as much as 90 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing and would be open space.

This total area of 320 acres would support about ten cows yearlong if continued in use for grazing land as at present. A perimeter fence would enclose DWB's 485 acres at the plant site, permitting continued livestock grazing on 165 acres north of and outside the security fence. This area would support five cows yearlong. Construction of Conduit No. 27 would disturb about 105 acres of grazing land for five years until fully revegetated and about 20 acres of cropland (probably small grains) for not more than one growing season. If the plant complex were expanded to treat 500 mgd, at least one additional large capacity conduit, capable of carrying at least 350 mgd, would be buried alongside Conduit No. 27 within the existing DWB right-of-way, causing temporary surface disturbance of approximately the same acreage that would be involved in placement of the initial conduit, with about the same temporary impacts.

It is probable that without the project the right-of-way between Colorado Boulevard and County Line Road would be fully developed for moderate density residential use by 1990, assuming the present linear growth rate of 0.1 miles per year continues. Through this section, owing to fairly intense adjacent development, the corridor would be very noticeable. South of County Line Road, it is probable that by 2001 present grazing use would be largely converted to agricultural subdivisions (zero to one dwelling unit per 10 acres) as far as U.S. Highway 85. In this segment, the large amounts of open space planned and the extremely low residential density would allow developmental layout and design to accommodate the right-of-way without creating a noticeable corridor to the casual observer. The remainder of the corridor, to just north of the treatment plant, would probably develop as agricultural subdivisions and for light industrial use. As with the previous segment, the right-of-way would control layout and design efforts; however, it should not be highly noticeable.

Traffic would probably have to be rerouted or at least restricted to half the available roadway during construction of the first and second conduits, creating delays and inconvenience for motorists. The greatest impacts would be felt by users of South Colorado Boulevard and South Holly Street, where Conduit No. 27 and the second parallel conduit would be laid in the street for more than 1 mile each. The impact of construction for the second conduit would be greater, but this is not quantifiable.

The movement of materials and workers during construction and chemicals and workers for operation and maintenance of the proposed Foothills Project would affect the transportation system. Most significant would be the movement of an average of 400 workers per day to the area during the three years of construction of the 125 mgd plant.

If two persons were to ride in each vehicle to the construction sites, traffic one way would be increased by about 200 vehicles per day for a total daily increase of 400 vehicles for the three-year period. Construction traffic would add an estimated 100 vehicles to the area's highways daily. It is probable that during the first year of construction nearly all worker traffic would funnel onto Colorado State Highway 75 between Wadsworth Boulevard and Kassler. This would increase those average daily traffic volumes from 7,900 vehicles per day to about 8,300 vehicles per day. Beyond the junction with Wadsworth the traffic would probably spread out into the transportation network, the effects ultimately becoming negligible. The additional traffic during morning and evening rush hours would probably not affect vehicle movement noticeably. Even less noticeable would be the effects of an estimated additional 100 vehicles per day from construction traffic. This traffic would be added during times when normal traffic would be relatively light, therefore offsetting the impacts. In addition, most of this traffic would be from the aggregate source just north of Kassler to the proposed construction sites in the South Platte Canyon and at the treatment plant complex.

Construction increments at the treatment plant for expansion to the 500 mgd and construction of the second conduit would add about fifteen cars per day, one way to local traffic during the total of seven years, between 1983 to 2001. This impact is considered insignificant.

Operation of the 500 mgd treatment plant would add as many as 70 vehicles per day to the existing traffic volumes, the result of 35 workers traveling to and from the treatment plant site. Delivery of chemicals for operation of the plant would add about two to eight trucks per day to the transportation system.

Future peak-day water demands with Foothills at 500 mgd may, for infrequent periods of short duration during the summer, require bringing water through the Roberts Tunnel at rates up to about 1,000 cfs. Even with the channel modifications, there could be some minor, temporary flooding of hay meadows adjacent to the stream. These floodflows would be of low velocity with little potential for erosive damage to the meadows. Depending upon the time, these flood-flows could be beneficial,

by providing additional irrigation, or detrimental, as when hay had been cut but not removed.

These potential overland flows, for which DWB would anticipate purchasing easements, would in effect zone the property against construction of permanent buildings or similar uses that could not tolerate occasional flooding. This is not considered a significant problem as meadow areas are not generally suitable for permanent structures and, in the long run, good land use would probably require that they remain in meadow production.

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Following is Table 3-16, which summarizes the environmental impacts of the proposal at 125 and 500 mgd.

TABLE 3-16

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Socio-Economic Conditions	1. Employment and Manpower: an average of 400 people employed per year reducing unemployment of Denver area construction workers by 12.3% during construction period (3 years); 25 workers for operation and maintenance - for 75 years - life of project.	1. Employment and Manpower: expanding plant to 500 mgd, employment would average 27 workers per construction year, reducing unemployment among construction workers by 0.7% over 7-year construction period; 10 additional people needed for operation and maintenance for the life of the project.
	2. Accidents: 43 accidents/3 year construction period; 20 accidents for vehicles 75-year operating life; 16 accidents hauling trucks.	2. Accidents: with expansion to 500 mgd, an additional 35 construction accidents and 53 accidents with trucks.
	3. Income: 125 mgd would add 0.6% to Denver gross domestic product; 400 families and/or individuals would increase income in construction phase.	3. Income: 500 would add less than 0.6%; 192 families and/or individuals would increase income (all increments).
	4. Municipal and Industrial Water Systems:	4. Municipal and Industrial Water Systems:
	a. 125 mgd can meet maximum-day demands through 1988, consuming 286,883 ac-ft annually.	a. Additional treatment capacity beyond 125 mgd would be required in 1988 and also additional raw water supplies - 378,530 ac-ft, if no water conservation imposed, by year 2001.
	5. Community Lifestyles: lifestyles could remain unchanged until 1988.	5. Community Lifestyles: lifestyles could remain unchanged until 2001.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Water Resources	1. Surface water: if flows would exceed 4,400 cfs during construction of the dam, an additional 8,040 tons (4 ac-ft) of sediment would be deposited along the South Platte River, an increase of 11.5% over average annual sediment load.	1.
	2. Raw water supply of 79,100 ac-ft presently unused would be utilized in 1988.	2. Additional raw water would be required:
	a. Colorado River Watershed: surface water impacts would be same with or without the proposed action (see No Action, Chapter 8)	a. Colorado River Watershed: raw water sources would be needed and are arrayed in Chapter 8.
	b. South Platte River System: DWB's ability to divert raw water instantaneously would increase from 400 cfs to 595 cfs. Diversion from various points would vary.	b. South Platte River System: A maximum instantaneous demand for raw water would increase up to 775 cfs, 580 more than maximum for plant operating 125 mgd, resulting in greater velocity and increased depth. Maximum diversion requirement of 1,175 cfs if Marston and Kassler are also operating at capacity in peak-use periods.
	3. Water Quality:	3. Water Quality:
	a. Sedimentation: 0.04 ac-ft (75 tons) additional into South Platte annually. Inflow quality would determine water quality; turbidity is unquantifiable but would be reduced.	a. Presented in Chapter 8

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Water Resources (cont.)	b.	b. Increased diversions would increase salinity downstream.
Aquatic Resources	1. Construction would remove 1 acre of aquatic habitat in the South Platte River, or 192 lb. of trout.	1. Increased flows in North Fork of South Platte River would eliminate pools holding fish and reduce organisms requiring less velocity. Ecosystem below South Platte would change unquantifiably.
	2. Siltation would reduce bottom fauna and suffocate fish to reduce productivity an average 15% annually during 3 years of construction, a total of 1,224 lbs. of fish.	2.
	3. An increase from shoreline configuration to reservoir would increase total fish biomass 230%, but mainly non-game fish.	3.
	4. Inundation of spawning areas in 1.7 miles of stream would increase fishing upstream in fall.	4.
	5. One amphibian pond destroyed.	5.
	6. 44 feet drawdown of Dillon would concentrate fish and larger fish would survive. Exposing of mud flats would kill hibernating invertebrates or reptiles. Vegetation would freeze and recreation benefit.	6.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Geology, Minerals and Topography	1. Geology, mineral and topographic features would change, but not significantly.	1.
	2. Mining would be lost on the 95 acres to be occupied by dam and reservoir, but it is unlikely a minable ore deposit exists.	2.
	3. Seismic activity might increase by the impoundment of the water, unquantifiably.	3.
	4. 78% of 70,000 tons of sediment - 54,400 tons (21 ac-ft) - would probably be deposited in the reservoir annually.	4.
	5. 300,000 tons of aggregate would be excavated to construct the dam; no estimate of possible reserves has been made.	5.
	6. Access road cuts would be minor except from survey stations 340 + 50 and 354 + 50, where the old railroad bed would be eliminated.	6.
	7. At treatment plant, 4,490 lb. (3 cu. yds.) of sludge would be produced daily.	7. 28,500 lbs. of sludge would be produced daily.
Soils	1. Sedimentation: 28 acres would be disturbed in canyon from road constructions, to add 385 tons (0.3 ac-ft) of sediment to river in 10 years.	1.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Soils (cont.)	2. Power and Telephone Lines: 5 acres disturbed; 68.8 tons (1.036 ac-ft) of sediment added in 10 years.	2.
	3. Vegetation: clearing above high water line would disturb 30 timbered acres; 88% of sediments (60.5 tons) would deposit in South Platte initially; an additional 75 tons/yr. would be deposited over the 3-year construction period (225 tons total).	3.
	4. East portal area: 30 acres of disturbance.	4.
	5. Construction of Access Road: 11 acres disturbed; 22.5 tons (0.012 ac-ft) of sediment yielded.	5.
	6. Portal access, staging area, pond area: yield 100 tons (0.052 ac-ft) of sediment over 7 years.	6.
	7. Treatment plant complex: 145 acres disturbed, yield 167.5 tons annually of sediment with 335 tons (0.173 ac-ft) over 3 years. Also disturbed area would produce 935 tons (0.483 ac-ft) of sediment.	7. Treatment plant complex: additional 90 acres disturbed, producing 70 tons of sediment annually, 140 tons (0.07 ac-ft) over 2 years. Also, disturbed area would produce 1,445 tons of sediment: 95 acres would be disturbed between years 1983-2001, yielding 575 tons of sediment; 204 acres of vegetation would be disturbed; 114 acres permanently disturbed by structure.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Soils (cont.)	8. Conduit No. 27 would disturb 105 acres; 787.5 tons of sediment would be yielded over 5 years. The second parallel conduit would disturb 105 acres, yielding 787.5 tons of sediment between 1983-2001. These conduits would disturb a total of 210 acres of vegetation, none permanently.	8.
Terrestrial Resources	1. Vegetation: 136 acres disturbed, 128 permanently lost with 100 large trees; 582 acres temporarily disturbed, with 5 years required to return near-full production in grassland zones and 10 years in montane and riparian zones. Permanent loss of 27 acres of riparian habitat affected by 15 acre gain, a net loss of 12 acres, plus 10 years loss of habitat.	1.
	2. Wildlife disturbance would be general and adverse in canyon during construction.	2.
	a. Bighorn sheep: 3-year construction period would result in as much as 50% loss of herd.	a.
	b. Endangered Species: Peregrine falcon. Loss of riparian habitat and human harrassment could cause abandonment of nesting site.	b.
	c. Other animal species: one golden eagle eyrie would be deserted until after construction. Deer, mountain lion, and bear would be disturbed and driven out by construction. Raptors and other herds could be killed by flying into the power lines.	c.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Climate and Air Quality	1. Air pollution: fugitive dust and emissions for 30 months construction.	1.
	2. Accidental spillages could occur, but are unquantifiable.	2.
Noise	1. Construction could raise noise to 80-90 dBA 50 feet from the equipment; canyon and foothills now have 32-60 dBA. Blasting would also disturb the wildlife and people living nearby.	1.
	2. After construction ambient sound level would be reduced from 60 to 50 dBA.	2.
Visual Resources	1. Inundation and Increased Streamflows: radical but not unpleasant change at reservoir; sustained flow at river would reduce visual variety.	1. See Table 3-14 for summary of visual impacts at year 2001.
	2. Strontia Springs Dam: radical change to man-made feature from relatively disturbed landscape would produce high contract.	2.
	3. Dam Crest Road: linear scar would be produced.	3.
	4. Road Widening: high impacts in cut and line.	4.
	5. Staging Area: similar to dam.	5.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Visual Resources (cont.)	6. Power and Telephone lines: very prominent linear impacts.	6.
	7. Foothills Treatment Plant: radical change from structural, but not from landform or vegetative standpoint.	7.
	8. Conduit No. 27 and second parallel conduit not excessively high visual impacts.	8.
Cultural Resources		
Archaeological Resources	Impact significant because the plains area has potential site density, because archaeological sites are dwindling, and because there is evidence of Paleo-Indian sites, rarest in American archaeology. Damaged or destroyed or as yet undiscovered sites are of high impact.	
Historical Resources	1. Total loss of sites through the project are tabularized by impact.	1.
	2. Minor secondary impacts are also tabularized by impact.	2.
Paleontological Resources	204 acres at plant site and conduit excavations could encounter paleontological resources.	

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mdg 1/
Recreation	1. Vegetation removal would affect wildlife, especially Bighorn sheep.	1.
	2. Construction (3 years) would lose 30,000 visits.	2.
	3. Construction noise and activity would drive animals away, especially 50% of the Bighorn sheep herd.	3.
	4. Construction would cause loss of historical recreational viewing.	4.
	5. Dam would impose traffic barrier; through bicycle traffic would be eliminated.	5.
	6. Filling the reservoir would cut down fishing.	6.
	7. Recreation would change from rushing streams to placid reservoirs with attendant littering.	7.
	8. Access road would decrease wildlife habitat and aesthetic appearance. Power lines would also detract visually.	8.
	9. Upstream impacts would concentrate in the North Fork assuming flow schedules in upper South Platte would remain same.	9. On the North Fork, increased flows would reduce recreation; the amount is unquantifiable.

1/ Where blank spaces occur, no impact could be assessed.

TABLE 3-16 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of 500 mgd 1/
Land Use	1. 117 acres diverted by dam and reservoir to water diversion.	1.
	2. 9 acres of road; 8 more acres disturbed for 10 years.	2.
	3. 5 acres disturbed by power lines.	3.
	4. 30 acres of grazing land used for construction for 3 years.	4.
	5. Treatment plant construction disturb 135 acres for 3 years; 255 acres would be enclosed by security fencing.	5. Between 1983-2001, an additional 49 acres would be permanently and 90 acres temporarily disturbed.
	6. 65 acres would be open space; 320 acres would support 10 cows annually.	6.
	7. Conduit No. 27 and the second parallel conduit would disturb 105 acres of grazing land 5 years and 20 acres of cropland 1 year.	7. One additional large conduit would create same disturbance as Conduit No. 27.
	8. Density in residential use 0.1 mi/yr linear rate.	8. Present grazing land would probably become agricultural subdivisions.
	9. Rerouting of traffic would cause unquantifiable inconvenience. Traffic of 400 workers/day for 3 years. ADT volume from 7,900 to 8,300 vehicles per day.	9. 70 more vehicles per day and 2-8 trucks would be added.
	10. Overland flows might occur.	10. Overland flows might occur.

1/ Where blank spaces occur, no impact could be assessed.

CHAPTER 4

MITIGATING MEASURES

INTRODUCTION

The mitigating measures analyzed in this chapter are actions which will in some way reduce or eliminate impacts identified in Chapter 3. Each measure is analyzed in relation to a specific component of the proposed action, and the nature and degree of its effect is described. The mitigating measures will be required when and if the proposed project is approved.

Mitigating measures are required by governmental agencies with legal jurisdiction and will be monitored and enforced. Mitigating measures also include measures which the applicant, the Denver Water Board (DWB), has included as non-structural commitments, called Applicant Committed Measures. These will not be enforced; the DWB has committed themselves publicly to them.

Mitigating measures cover the east portal and staging area, the treatment plant complex, Conduit No. 27, and the second conduit parallel to it. In Waterton Canyon all mitigating measures including those proposed by the applicant concerning the U.S. Forest Service, BLM, and other public lands will be included in the right-of-way permits should they be issued. The project components in the canyon include access roads, the Stevens Gulch staging and portal area, the Strontia Springs Dam and Reservoir, and the power and telephone lines. Measures identified relative to these project components will be made conditions of stipulations of the permits and will be enforced jointly by BLM and USFS personnel.

MEASURES

Right-of-way: Dam, Reservoir, and Tunnel

Bureau of Land Management

1. BLM is limiting the clearing of vegetation to the area within the reservoir, which is below 6,010 feet of altitude, in order to decrease erosion associated with the project. This will also reduce turbidity in the South Platte River, benefiting aquatic life to an unquantifiable degree. The DWB will chip most of the vegetative material generated by clearing the reservoir area up to 6,010 feet of elevation and will dispose

of the chips as mulch in the disturbed area above the high-water line. This will help reestablish vegetation, hold moisture in the soil, and prevent erosion.

2. The DWB will use mulching to help revegetate disturbed areas, hold soil moisture, and prevent erosion when cleared vegetation is not available for chips.

3. The DWB will strip topsoil from tunnel muck disposal sites and the east portal area and stockpile it before construction of the tunnel. After construction is completed, in three years, the disturbed areas will be shaped, recovered with topsoil, and revegetated using the same methods referred to in the discussion of the Stevens Gulch staging area (16).

4. The DWB will strip and stockpile topsoil, reshape disturbed areas, recover with topsoil, and seed land around the treatment plant complex to provide a natural appearance on about 80 acres. Of these, 4 acres will be landscaped with lawn, trees, and ornamental shrubs with a fixed irrigation system as proposed in Chapter 1. The remaining 76 acres will be revegetated with native plants and will not have an irrigation system. This measure will mitigate some of the adverse visual impacts of the treatment plant and reduce runoff during construction. Similar measures will be applied to the area as the plant is expanded to 500 mgd.

5. The DWB will stockpile the topsoil, shape disturbed areas, recover with topsoil, and seed 105 acres of disturbed soils along Conduit No. 27. This will establish vegetative cover after construction is completed, reducing sediment yield, impacts on grazing use of the land, and impacts on aesthetic values. The same effects are expected and the same measures will be applied to construction of the second conduit parallel to Conduit No. 27.

6. The DWB will reclaim in a similar manner the area along Conduit No. 26 and the Aurora intertie conduit. Part of this will be reclaimed during the three-year construction period of the 125 mgd plant. Most of the site, however, will not be reclaimed until after construction is completed. The expansion of the treatment plant to 500 mgd capacity will not further affect the site. The visual impacts of this construction are so closely associated with those of the treatment plant that they are not differentiated.

7. BLM is requiring that the DWB compensate for the 1.7 miles of free-flowing stream that will be lost to the reservoir. To do this, the DWB will bypass at the Strontia Springs Dam 60 cfs of water at Waterton gage into the South Platte River from May 15 to September 15. The DWB will bypass 30 cfs at Waterton gage from September 16 to May 14. Exceptions to this will be allowed during an emergency or during temporary periods involving maintenance or repairs of water facilities or during periods of water shortage. The bypassing of this water to maintain South Platte flows at a certain level is a loss of water to DWB, and DWB will be given consideration for this in some of its future projects by BLM.

8. BLM is requiring the DWB to develop and fund a stream improvement program between the South Platte intake and Kassler treatment plant. This measure is intended as further compensation for the loss of 1.7 miles of stream to the reservoir. The stream improvement program will consist of installation of the necessary log weirs, deflector configurations, braided stream sections, and random rock placements. Detailed examples of such a stream improvement program appear in Appendix 2. This program, developed by the DWB, will be approved by the Colorado Division of Wildlife (CDW), BLM, and the U.S. Fish and Wildlife Service (FWS) before implementation. Plans for the program will be submitted for approval by the end of construction and completely implemented no later than two years after that.

This stream improvement program discussed above will require in-stream or streamside construction in the form of log or rock weirs, or log or rock deflectors, and will require a future Section 404 Permit from the Corps of Engineers before DWB implements this program. At the time this 404 permit is applied for, all NEPA requirements will have to be met on whatever impacts would occur as a result of this action.

9. The BLM will require that the loss of 30,000 recreation visits to Waterton Canyon during the three-year construction period be partially compensated for by leaving open to recreationists the upper portion of the canyon, from the upper railroad bridge to South Platte Townsite.

To provide for the safety of recreationists and construction personnel, closure of the canyon at the railroad bridge will consist of high security fences and warning signs.

10. BLM will require that the DWB build and maintain a replacement public access trail (non-motorized), an estimated 2.5 miles long, to preserve safe public passage around the Strontia Springs Dam and Reservoir. The trail will mitigate the loss of 1.7 miles of canyon for recreation by providing visitors enjoyment of fishing and wildlife. It will also provide some control of recreation use and reduce littering and trampling in adjacent areas. Location and design of the trail will be subject to approval by BLM and USFS and will be completed coincident with reopening the canyon to the public. The trail will be built with a minimum width of 4 feet for a walking surface, with grades not to exceed 15 percent, with drainage to minimize the effects of erosion, and with sanitation facilities.

The trail will create new adverse impacts. Building the trail will take about one year and will be completed no later than the end of construction. It will disturb about 2 acres. About 1 acre can be reclaimed, requiring five years to regain near-normal productivity of vegetation under normal conditions. During that time, about 7.5 tons of sediment will be lost to the reservoir.

11. BLM will require the DWB to mitigate the adverse effects of construction on known or potential historical, archaeological, and paleontological resources. Methods and techniques will vary with a number of factors, including the location of the site and its significance.

Specific mitigating measures will be determined site by site. Such measures include the following:

a. Avoidance. This may be accomplished, where feasible, through project redesign.

b. Preservation through recordation. This is most appropriate for sites that would be destroyed whose significance is the information they contain.

  1) Photographic records and measured drawings to Historic American Building Survey standards are required prior to demolition of a property included in or eligible for inclusion in the National Register of Historic Places (E.O. 11593 Sec. 2c).

  2) Surface collection of cultural remains and recording of distribution of artifacts and features may be adequate in some instances.

  3) Major excavation of an affected site according to a specified research design will be necessary when a significant site will be lost or greatly altered.

  4) Salvage excavation is considered a minimal effort. Specific mitigating actions must be developed in consultation with the Colorado State Historic Preservation Officer (SHPO) and the Advisory Council on Historic preservation in accordance with "Procedures for Protection of Historic and Cultural Properties," (36 CFR Part 800) pursuant to Section 106 of the National Preservation Act of 1966, as amended September 28, 1976 (PL 94-422) and Executive Order 11593.

In order to comply with the provisions of these authorities, an intensive archaeological examination will be necessary for all areas which will be directly affected by ground-disturbing activities. In addition to this examination, the following requirements must be met:

a. An evaluation of each cultural resource located for eligibility for inclusion in the National Register must be made.

b. In consultation with the SHPO, Determination of Effects of the proposed action on properties included in or eligible for inclusion in the National Register must be made.

c. Transmittal of Findings of Effects to the Advisory Council on Historic Preservation for comment with appropriate documentation, including comments of the State Historic Preservation Officer, depending on the type and extent of effects, must be made.

d. Avoidance or mitigation of effects is sometimes necessary. Potential adverse impacts must be evaluated following compliance procedures when an implementation action that threatens any site is proposed.

Excavation at the treatment plant complex and along Conduit No. 27 and the second conduit parallel to it may disturb paleontological resources. This area will be examined for these resources and will also be monitored as described in the monitoring section later in this chapter.

12. The impacts of the proposed action on historical values in Waterton Canyon, on the North Fork of the South Platte, and on the South Platte River from Cheesman Dam were evaluated. The following sites will be specifically mitigated:

<u>Keystone Bridge</u>. This site, eligible for the National Register and under the protection of Section 106, will require no less than a recordation under the Historic American Engineering Record (HAER) by qualified professional engineers and photographers. Further, regardless of the final disposition for this site, the bridge will require a Section 106/2b statement.

Concurrence with the State Historic Preservation Officer and the National Advisory Council will be sought after the preparation of a 106/2b statement.

<u>D&RGW Rockwork</u>. This site will be inundated and will be fully recorded via HAER standards prior to destruction.

North Fork Historic District. This district is National Register property and is therefore under 106 protection; thus, it will be provided a 106/2b statement prior to any actions by the applicant that will be either beneficial or damaging to the District. There have been twelve sites identified within the area that will be impacted by increased flows along the North Fork of the South Platte River.

The following sites are located within the boundaries of the North Fork Historic District and therefore will need mitigation. This requires Section 106 statement(s) and concurrence with the SHPO and the Advisory Council prior to any action.

Westall Monument. Site No. FH-001. This site will require recordation and stabilization to prevent its being damaged by increased flows.

Longview, Colorado. Site No. FH-007. This site will require recordation prior to action and possible diversion of overflow waters from around buildings and sites that will be damaged by water.

Dome Rock, Colorado. Site No. FH-008. This site will require recordation prior to any action and then may require diversion around the sites that may be damaged by water.

Foxton, Colorado. Site No. FH-011. This site will be impacted through increased flows. Retaining walls will be needed in this section of the North Fork to prevent erosion and undercutting of a cabin and barn along the south side of the river.

The DSP&P Railroad Bridge Abutment at Buffalo Creek. Site No. FH-012. This site will be undermined by increased flow. Retaining walls will be placed around the base of the pilings.

DSP&P Railbed, Buffalo Creek to Pine. Site No. FH-014. This site will be partly flooded and the erosion caused will bring about some undermining of the embankment. Those areas that will flood will be protected with retaining walls. The site will be recorded via HAER.

Pavilions at Glenisle. Site No. FH-017. These sites appear to be of National Register quality. Thus, they will be provided with HABS recordation and then moved out of the path of the overflow.

DSP&P Rail Bridge (Estabrook). Site No. FH-017. This site will be impacted by increased flows along the North Fork and will be damaged by erosion. The site appears to qualify for the National Register and therefore will be fully recorded via HAER; then retaining walls will be built around the pilings to prevent damage.

The seven sites discussed above (Site Numbers FHS-001, 7, 8, 11, 12, 14, 17) which require in-stream or streamside construction in the form of bank stabilization, rock berms, and retaining walls, will require a future Section 404 Permit from the Corps of Engineers at the time the high flows will impact these historic resources. These seven mitigating measures will cause various environmental impacts (i.e., aquatic and terrestrial habitat) on the specific sites where required work is to be done. At the time that the 404 Permit is applied for, all NEPA requirements will have to be met on these impacts.

Right-of-way: Access Roads

Bureau of Land Management

13. BLM will require the DWB to use periodic spraying of roads and staging area by water trucks to control dust from wind, vehicles, and equipment.

14. BLM will require the DWB to paint all permanent structures and stain all permanent exposed concrete with colors that will be compatible with the surrounding landscape in order to mitigate the impacts on visual resources in the Stevens Gulch staging area.

15. The DWB will use mulching to help revegetate disturbed areas, hold soil moisture, and prevent erosion when cleared vegetation is not available for chips.

16. The DWB will stockpile topsoil, smooth disturbed areas, cover them with the stockpiled topsoil, and revegetate by seeding along roads in Waterton Canyon and at Stevens Gulch staging area. The addition of topsoil and seeding will allow seedlings to become established during the first full growing season. This will reduce sediment loss to the South Platte River, thereby benefiting aquatic life and aesthetic values.

Right-of-way: Power and Telephone Lines

Bureau of Land Management

17. BLM will require that power and telephone lines be constructed according to guidelines from the Raptor Manual, available upon request from BLM.

> "The applicant, grantee or licensee shall be governed by 'Suggested Practices for Raptor Protection on Powerlines'. Use of this information should be made to design the proposed (____fill in name____) kV powerline for designated raptor areas with proper grounding, phase spacing and configuration such that it will prevent, to the best of the design engineer's ability, the electrocution of raptors. The applicant shall provide for the grantor, or licensor, drawings which show phase spacings, configurations and grounding practices of the proposed line, and these shall be made a part of the permit.
>
> The use of designs other than those included herein that are, in the opinion of a raptor expert, raptor safe, shall be permitted on public land rights-of-way. The costs for review of such alternate designs shall be at the applicant's expense.

The grantor, or licensor, in issuing this permit, hereby assumes its responsibility to inform the applicant, grantee, or licensee of those areas which are designated habitats or potential habitats of raptors or other birds of prey. Any available biological or land management information in meeting the above-stated goal shall be made available to the engineer. (BLM Instruction Memo 76-45)."

This measure will save an estimated one raptor annually.

18. BLM will require power and telephone lines to be located as carefully as possible to minimize disturbance of soil and vegetation during construction and to avoid "skylining," appearance of lines against the horizon when viewed from the roadway. Care in locating utility lines can be the most important element in reducing their visual impact.

19. BLM will require clearance of vegetation under utility lines to be minimized. In addition, no soil disturbance will be allowed except that necessary to install the poles. Disturbing the vegetative pattern by clearing under a line tends to focus attention of an observer on the disturbed area. This measure will not only reduce the visual impact of utility lines and poles but will also diminish sediment yield and correspondingly reduce impacts on aquatic life.

20. BLM will require that non-reflective cable be used for all lines and guy wires in Waterton Canyon in order to reduce their visual impact. Reducing the reflection of sunlight on wires makes them less visible and may endanger low flying airplanes and helicopters, but few aircraft venture low enough in the canyon for this to be considered a significant hazard.

ANALYSIS OF EFFECTIVENESS

Vegetation

The principal effect of clearing vegetation associated with the project is the loss of sediment and adverse visual impacts. The degree to which these effects are felt will vary depending on the nature of the area being disturbed.

According to the proposed action, 117 acres of vegetation would be cleared from the reservoir area, resulting in the loss of 75 tons of sediment annually. Applying mitigating measure (1), only 95 acres would be cleared, only that area below 6,010 of elevation. This would reduce the sediment lost by 15 tons per year. There would remain a residual sediment loss of 60 tons per year, or 180 tons during the three-year construction period.

The vegetation cleared from the reservoir area will have to be disposed of. Under mitigating measure (1), this vegetation will be chipped and used as mulch for disturbed areas around the reservoir area above the high-water line. This will help reestablish vegetation more rapidly, hold moisture in the soil, and ultimately help reduce erosion. The effectiveness of using chipped vegetation is measured in combination with hydro-mulching and is discussed in connection with specific sites, below.

The 2.5 miles of public access trail that the DWB will build around the Strontia Springs Dam and Reservoir, which is itself mitigating measure (10), will disturb about 2 acres. Of these, about 1 acre could be reclaimed, for which about five years would normally be required. During this time, 7.5 tons of sediment would be lost to the reservoir. If measure (15), hydro-mulching, were employed, revegetation would require only about three years, with a loss of only about 6 tons of sediment.

If vegetation is cleared under power lines and poles, about 5 acres would be removed, resulting in the loss of 68.8 tons of sediment and an accompanying but unquantifiable impact on aquatic life. If soil disturbance under power lines and poles is minimized by mitigating measure (19), the clearing of vegetation only where poles are installed, the disturbance of soil and resulting sediment loss would be reduced to near zero.

Vegetation removed for the construction of access roads in Waterton Canyon will disturb about 28 acres. During the ten years it would take for the area to revegetate under normal conditions, 385 tons of sediment would be lost to the South Platte River, with an unquantifiable effect on aquatic life. By application of mitigating measure (16), stockpiling

topsoil, smoothing disturbed areas, recovering them with topsoil and reseeding, the disturbed area would be restored in five years instead of ten. The total sediment loss would be reduced from 385 tons to 210 tons.

Vegetation removed from Stevens Gulch for the east portal staging area and access road would disturb 11 acres and result in the loss of 122.5 tons of sediment over seven years for revegetating under normal conditions. Applying mitigating measure (16), described above, revegetating would only require five years with a loss of 95 tons of sediment.

Tunnel muck disposal sites will be stripped of topsoil before construction of the tunnel. After construction is completed, the disturbed area will be reshaped and revegetated (mitigating measure (3)) employing measures discussed in association with the Stevens Gulch staging area (16). The impact of these disposal sites is minimal and is combined with the staging area impacts.

Vegetation will be cleared from 135 acres at the site of the 125 mgd treatment plant. If allowed to revegetate naturally, there would be a loss of 860 tons of sediment over seven years. Of the 135 acres disturbed, about 80 acres will remain to be reclaimed after construction of the treatment plant is completed. The DWB will landscape (mitigating measure (4)) about four of these with lawn, trees, and ornamental shrubs with a fixed irrigation system. About 5 acre-feet of water will be required to maintain this area annually. The remaining 76 acres will be revegetated with native plants and will not have an irrigation system. This area is expected to become established during the first full growing season. The chances of successful seeding in this climatic zone are exceptional; over 70 percent of the precipitation occurs during the growing season. By the planting of seed and replacement of topsoil as in mitigating measure (16), vegetation should be reestablished in about five years instead of seven years under natural conditions. Instead of a sediment loss of 860 tons, there will be a total sediment loss of only 685 tons.

When the plant is expanded to 500 mgd, the total additional disturbance will be 90 acres, requiring a recovery period under normal conditions of seven years and losing a total of 575 tons of sediment. With the application of mitigating measures (16) and (4) as above, the revegetation period would be reduced to five years and a total residual loss of 453 tons of sediment.

Clearing vegetation in the construction of Conduit No. 27 would disturb 105 acres. Implementing mitigating measure (5), the stockpiling of topsoil, shaping of disturbed areas, recovering and reseeding as in mitigating measure (16), would reduce the time of revegetation from seven years to five and the loss of sediment of from a total of 787.5 tons over seven years to 525.1 tons over five years. Adverse impacts on the grazing use of land would be diminished by 40 percent.

The same effects would occur and the same measures would be applied during the construction of the second conduit parallel to Conduit No. 27.

Vegetation cleared along Conduit No. 26 and the Aurora intertie conduit would disturb an area of 10 acres. Applying mitigating measure (22) and the techniques employed in mitigating measure (16) for revegetation, three years would be required instead of five under normal conditions, reducing the loss of sediment from 75 tons over five years to a total of 50 tons during three years. Part of this area will be reclaimed during construction of the 125 mgd treatment plant, most of it reclaimed after construction is completed. The expansion of the treatment plant to 500 mgd capacity will not further affect this specific site.

Aquatic Resources

By limiting the clearing of vegetation to within the reservoir area, (below 6,010 feet of altitude - mitigating measure (1)), sediment loss will be reduced from 75 tons to about 60 tons annually, or 180 tons during the three-year construction period. This will reduce turbidity in the South Platte River and benefit aquatic life to an unquantifiable degree.

To compensate for the loss of fish production in 1.7 miles of stream when it is inundated by the reservoir, the DWB will apply mitigating measure (7) - bypass 30 cfs at Waterton gage from September 16 to May 14, and 60 cfs of water from May 15 to September 15.

In addition, the DWB will develop and fund a stream improvement program between the South Platte intake and Kassler Treatment Plant mitigating measure (8). This will consist of necessary log weirs, deflector configurations, braided stream sections, and random rock placements.

This program will increase aquatic life production, thereby benefiting fish production and increasing recreational opportunities in the canyon. Some measure of the results obtainable by such a program may be seen from research conducted in Wisconsin (Hunt 1971). Figure 4-1 shows the results of habitat development carried out in Lawrence Creek, Wisconsin. Annual biomass was increased 41 percent. Assuming comparable results from a stream improvement program in the South Platte River, 37 pounds of brown trout per acre now estimated for Study Area 3 (Map 2-1 and Table 2-16) could be increased to 52 pounds, the present estimated population for Study Area 1. There would also be a comparable increase in the standing crop of rainbow trout. Since there is no estimate of the present standing crop of rainbow trout for Study Area 3, the improvement cannot be quantified.

Recreation

During the three-year construction period of Strontia Springs Dam there would be a lost 30,000 recreation visitations to Waterton Canyon. This will be mitigated by measure (9), leaving open the upper portion of the canyon, from the upper railroad bridge to South Platte. This will allow 4,000 visitors to use the canyon

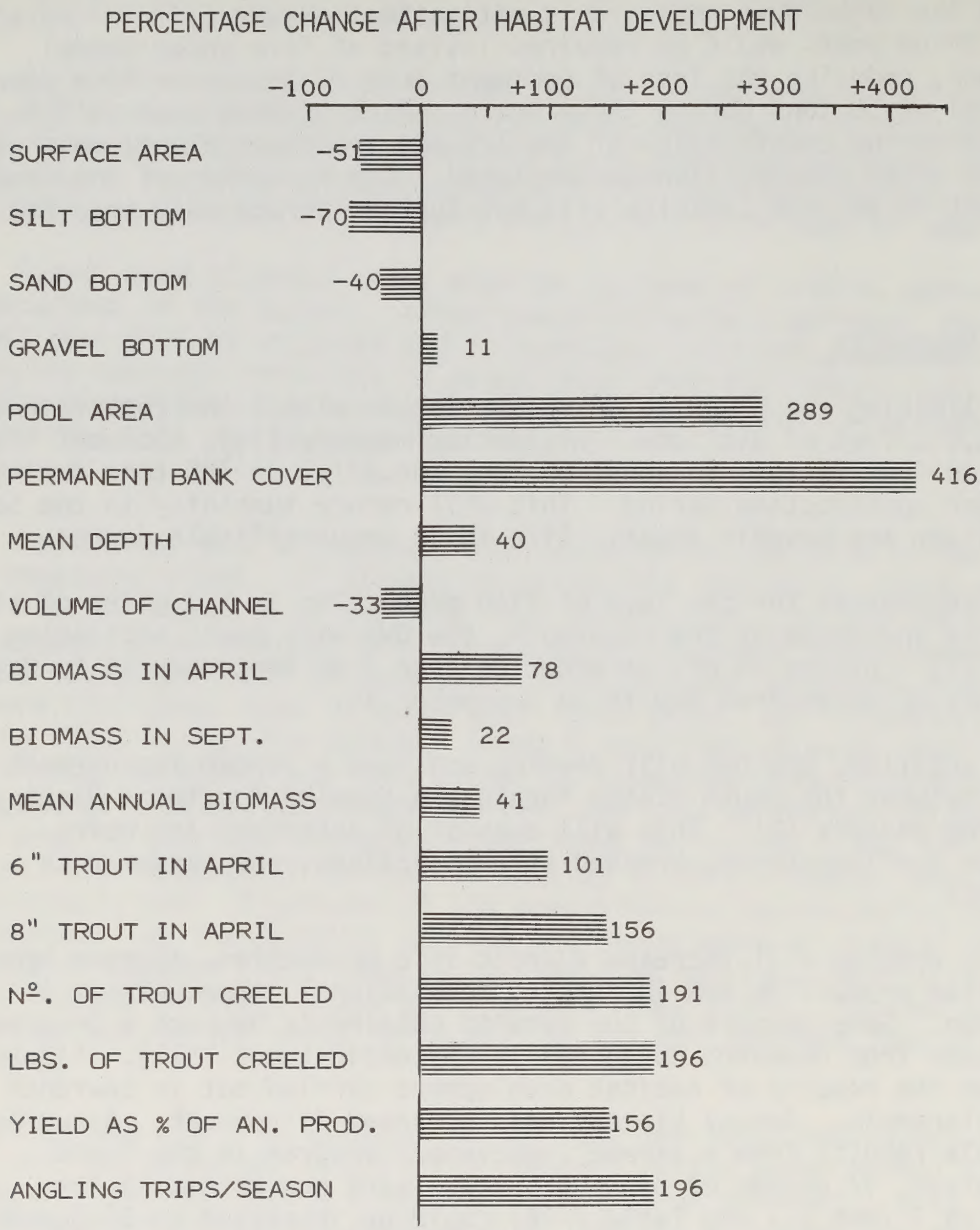


Figure 4-1. Average changes in several physical characteristics, trout population parameters, and the fishery 3 years following completion of habitat development, Lawrence Creek, Wisconsin (Hunt 1971).

annually. There will be a residual loss of 18,000 visitations over the three-year construction period.

After the dam is completed, loss of recreation visits due to inaccessibility of the dam site will be mitigated by (10), the construction and maintenance by the DWB of 2.5 miles of non-motorized access trail around Strontia Springs Dam and Reservoir. This measure will totally eliminate recreation losses after completion of the trail.

Historical Resources

There is potential destruction of historical sites within Waterton Canyon, the North Fork of the South Platte River, and the South Platte River from Cheesman Dam. These are detailed under the heading Measures, and will be mitigated by measure (11), which consists of several standard measures of preserving historical values. These include avoidance, recordation, consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. These are difficult to quantify; in general, historic values will be partially salvaged or totally preserved. These are detailed under measure (12).

Archaeological Resources

Potential destruction of archaeological sites within Waterton Canyon, along the North Fork of the South Platte River, and the South Platte River and Treatment Plant site will be mitigated by standard procedures detailed for archaeology in measure (11). These include examination of potential sites, evaluation, determination of effects of the project on the site, if any, and consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. Archaeological resources in this area are unknown and the impact of the project on them is presently unquantifiable.

Paleontological Resources

Potential destruction of paleontological resources within Waterton Canyon, along the North Fork of the South Platte River, and the South Platte River and Treatment Plant site will be mitigated by standard procedures, detailed under paleontology in measure (11). Excavation at the treatment plant complex and along Conduit No. 27 and the conduit parallel to it is most likely to disturb paleontological resources. This area will be examined for these resources and will be monitored by a competent vertibrate paleontologist, as described in the monitoring section later in this chapter. At present, the extent of these resources is unknown and the impact on them therefore unquantifiable.

Air Quality

Dust from wind, moving vehicles and equipment in staging areas will reduce air quality in the construction area. Dust will be controlled by mitigating measure (13), the periodic spraying of water to control dust. Some impact will remain, but it is unquantifiable.

Visual Resources

Structures in the Stevens Gulch Staging area will be visually incompatible with the surrounding landscape. Applying Measure (14), the painting of all permanent structures and the staining of all permanent exposed concrete will mitigate the adverse visual impacts associated with them. This will reduce visual contrast rating from 21 to 17, closer to the acceptable contrast limit of 16.

Power and telephone lines will be highly visible from the roadway in Waterton Canyon, producing an effect known as "skylining." This will be mitigated by (11), the placing of such lines as carefully as possible to avoid this effect. The difference in visual contrast rating of these lines before and after mitigation cannot be quantified. This is also true of the mitigation of skylining by measure (20), the use of non-reflective cable.

Mitigation of the visual contrast rating for the Stevens Gulch staging area before and after mitigation through revegetation (measure (16)) is not quantifiable. Even without mitigation, the disruption of vegetative patterns will produce a visual contrast rating of 10, well within the acceptable limit of 20.

Revegetation of the Treatment Plant area (measures (4) and (6)) will not change the unmitigated visual contrast rating of 27, which is over the acceptable limit of 20. This is unavoidable because the landscaping of 4 acres around the Treatment Plant site will produce an abnormally green area (in contrast to the general background), which will be as visually disruptive as the site without mitigation

The mitigation of the visual contrast rating for Conduit No. 27 and the second conduit parallel to it through revegetation (measure (5)) are not quantifiable, although the disturbance of vegetative patterns even without mitigation are within acceptable limits. Each conduit would produce a contrast rating of 10 for vegetative patterns without mitigation. The acceptable limit is 20.

Terrestrial Resources

The killing of raptors on power lines will be mitigated by (17), constructing power and telephone lines according to guidelines presented in the Raptor Manual, available upon request from BLM. This measure will save an estimated one raptor annually.

SUMMARY OF ANALYSIS OF EFFECTIVENESS

Following is Table 4-1, which summarizes the impacts, mitigating measures (referred to by number) and the residual impacts discussed in the first two section of this chapter. The headings correspond, in sequence, to the categories in Analysis of Effectiveness, immediately preceding.

TABLE 4-1

VEGETATION

Impact	Mitigating Measure	Residual Impact 1/
Sedimentation from clearing of reservoir	(1)	80 percent (180 tons) sediment loss over three-year construction period
Disposal of cleared vegetation from reservoir	(14)	Unquantifiable
Sedimentation resulting from trail building	(15)	80 percent (6 tons) sediment loss over three years recovery time
Sedimentation from clearing for power lines and poles	(12)	None
Sedimentation from clearing for access roads	(16)	54 percent (210 tons) sediment loss over five years recovery time
Sedimentation from clearing of staging area (Stevens Gulch)	(16)	77 percent (95 tons) sediment loss over five years recovery time
Sedimentation from clearing tunnel muck disposal site	(16),(19)	Combined with staging area impacts
Sedimentation from clearing the treatment plant site (125 mgd)	(16),(20)	80 percent (685 tons) sediment loss over five years recovery time
Sedimentation from clearing the treatment plant site (500 mgd)	(16),(20)	79 percent (453 tons) sediment loss over five years recovery time
Sedimentation from clearing for Conduit No. 27	(16),(21)	67 percent (525.1 tons) sediment loss over five years recovery time
Sedimentation from clearing for the conduit parallel to Conduit No. 27	(16),(21)	67 percent (525.1 tons) sediment loss over five years recovery time
Sedimentation from clearing for Conduit No. 26 and Aurora intertie conduit	(16),(22)	67 percent (50 tons) sediment loss over three years recovery time

1/ Residual impacts are expressed as percentages of unmitigated impacts and actual residual loss and recovery time.

TABLE 4-1 (cont.)

Impact	Mitigating Measure	Residual Impact 1/
	AQUATIC RESOURCES	
Sedimentation from clearing of reservoir	(1)	Unquantifiable
Loss of fish production in 1.7 miles of stream	(7)	Unquantifiable
Loss of fish production downstream of Strontia Springs Dam	(8)	41 percent (15 lbs.) increase in fish production
	RECREATION	
Loss of recreation visits due to construction in Waterton Canyon	(9)	60 percent (18,000) loss of visits over three-year construction period
Loss of recreation visits due to dam induced loss of accessibility	(10)	None
	HISTORICAL RESOURCES	
Destruction of historical sites	(11),(12)	Unquantifiable; detailed qualitatively for specific sites
	ARCHAEOLOGICAL RESOURCES	
Destruction of archaeological sites	(11)	Unquantifiable; detailed qualitatively for specific sites
	PALEONTOLOGICAL RESOURCES	
Destruction of paleontological sites	(11)	Unquantifiable; detailed qualitatively for specific sites

1/ Residual impacts are expressed as percentages of unmitigated impacts and actual residual loss and recovey time.

TABLE 4-1 (cont.)

Impact	Mitigating Measure	Residual Impact 1/
AIR QUALITY		
Dust in staging area	(13)	Unquantifiable
VISUAL RESOURCES		
Structures in Stevens Gulch staging area	(14)	81 percent (17) visual contract
Skylining from power lines	(18),(20)	Unquantifiable
Disruption of vegetative patterns in Stevens Gulch	(16)	Unquantifiable; visual contrast remains at 10
Disruption of vegetative patterns at treatment plant site (125 & 500 mgd)	(4),(6)	Visual contrast remains at 27
Disruption of vegetative patterns along Conduit No. 27	(5)	Unquantifiable; visual contrast remains at 10
Disruption of vegetative patterns along the second conduit parallel to Conduit No. 27	(5)	Unquantifiable; visual contrast remains at 10
TERRESTRIAL RESOURCES		
Killing of raptors by power lines	(17)	Unquantifiable

1/ Residual impacts are expressed as percentages of unmitigated impacts and actual residual loss and recovey time.

MONITORING RESEARCH AND STUDY PROGRAMS

Water Quality

Requirements relating to preservation of the quality of interstate water are outlined in the Federal Water Pollution Control Act of 1972, as amended. The Colorado Department of Health will monitor water discharged from the dam construction area for pollutants identified in the permit. Water discharged after treatment must not deteriorate water quality in the South Platte River (Table 2-14). This measure also applies to discharge from the Stevens Gulch portal and staging area. According to the Colorado Department of Health, the most probable of the standards identified in Table 2-14 that will be affected are settleable and floating solids, oil and grease, temperature, and dissolved oxygen. A restriction will be imposed on the use of chlorine, a toxic material. In addition, a permit (required by Section 404 of the Federal Water Pollution Control Act (PL 92-500) will have to be obtained before construction of the dam can begin (see the section on Corps of Engineers, under Description of the Proposed Action, Chapter 1). Under this law, the Strontia Springs Dam is considered fill material discharged into the South Platte River.

Wildlife

Before beginning construction, the DWB will initiate a study to monitor the effects of human activities on the 60-65 head of Bighorn sheep during the three-year construction period in Waterton Canyon. Prior to its initiation, this study plan is to be outlined and approved by BLM and the USFS after consultation with USFS and CDW. In the event that there are serious adverse impacts on the herd of Bighorn sheep in Waterton Canyon, there are two options for action. The herd could be removed from the area and transplanted elsewhere, then brought back after the project is complete. The other possibility is to let the herd survive as well as it can under the existing conditions and replace as much of the herd as was lost.

Geology

Due to the possibility of reservoir-induced seismicity, seismic monitoring devices must be established by the DWB. These devices would monitor background seismicity and must include instruments sensitive enough to monitor microearthquakes, such as the MEQ-800B-Springnether. A network must be established for a minimum of two months before construction begins, and again for a minimum of six months as soon as filling commences.

Archaeology and Paleontology

On-site examination and monitoring will be carried out by the DWB during ground disturbing activity for all phases of construction to determine if archaeological and paleontological resources are present and may be identified. A competent archaeologist and vertebrate paleontologist will be used for this monitoring.

CHAPTER 5

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

INTRODUCTION

This chapter presents a discussion of unavoidable adverse impacts which would be caused by construction and operation of the proposed Foothills Project. These include the residual impacts after application of the mitigating measures discussed in the preceding chapter.

SOCIO-ECONOMIC IMPACTS

During the three years of construction of the first increment of the proposed project (125 million gallons per day) there would be an estimated 43 accidents related to general construction, underground mining, and motorized transport. During construction of the second, third, and fourth increments (125 mgd each), there would be an additional 35 general construction accidents and 53 motorized transport accidents. During the life of the project, about twenty accidents would occur that would involve motor vehicle transports. Chlorine accidents would be expected to occur at a rate of once every eleven years; ammonia accidents would be expected once every 22 years. Although spills of these toxic chemicals are improbable, they would involve possible injuries and adverse temporary impacts on air quality.

An unavoidable adverse socio-economic impact of the project would result from the lay-off of 460 construction workers hired during the three-year construction period of the first increment. Assuming that the contract construction unemployed labor force of 3,753 in the Denver - Boulder LMA for March 1977 remains constant (Table 2-1), the impact on this unemployment rate would be to increase it by 12.3 percent. Though the work forces for the second, third, and fourth increments would not be as large as that for the first increment, an average of 27 per construction year or a total of 81, there would be unavoidable social and economic impacts to the construction workers and their families from lay-offs following completion of each increment. The total effect on the contract construction employment rate would be to increase it by 2.3 percent.

WATER RESOURCES

Surface Water

Discussion presented in Chapter 1 indicated that when the full Foothills Treatment Plant capacity of 500 mgd is required, additional raw water supplies are also required. The development of such supplies will lead to reduced flows in the respective watersheds from which the waters are obtained, and increased flows in the watersheds in which the waters are used. Colorado River basin flows would be reduced, and South Platte River flows would both increase and decrease depending upon the specific reach upstream from Strontia Springs and downstream.

The proposed Strontia Springs Dam would create a new 95-acre lake in place of the existing 1.7 miles of river.

Waters that have been diverted at the existing Platte Canyon and Highline Canal diversion structures by the DWB would be diverted upstream at the Strontia Springs Diversion Dam at rates up to 195 cubic feet per second (cfs). If the Foothills Plant at 125 mgd is operated year-round, flows in the South Platte River between Strontia Springs Dam and the Platte Canyon Intake Diversion Dam would average 60,500 acre-feet per year less than the 1964-73 annual average of about 298,000 acre-feet. (Table 3-5).

These flows would have adverse impacts on aquatic, aesthetic, and recreation resources.

Water Quality

Additional diversions from the Colorado River basin using the DWB existing facilities would occur with or without the Foothills Project. Development of new raw water supply facilities in the Colorado River basin and the resulting diversions would increase salinity concentrations at downstream locations. Salinity would increase from 440 mg/l to 451 mg/l at Cameo, Colorado and from 861 mg/l to 868 mg/l at Imperial Dam, Arizona. Discussion of such salinity concentration increases is also presented in Chapter 8, under Alternative New Sources of Raw Water. The amount of increase would be dependent upon the configuration of the system implemented and the amounts of water diverted.

The water quality of the South Platte River would be affected by the addition of 447.5 tons (0.23 acre-feet) of sediment from the disturbed areas during the three years of construction in Waterton Canyon.

AQUATIC RESOURCES

The proposed 95-acre reservoir would permanently convert 1.7 miles of the South Platte River into a standing body of water. Suitable spawning areas in the 1.7 miles would be lost as the reservoir is filled. The dam and reservoir would destroy one amphibian pond.

There would be an estimated ten percent reduction in surface area in the 2.6-mile stretch of river between the proposed Strontia Springs Dam and the South Platte intake. However, with adequate flows, as discussed in Chapter 4, aquatic productivity would increase.

Increased flows as a result of the Foothills operating at 500 mgd could cause an unquantifiable increase in bank erosion and destroy riparian vegetation on an estimated twenty miles of the lower North Fork. This would probably be accompanied by a similarly unquantifiable reduction in the productivity of that aquatic and terrestrial habitat. If so, the fish crop would diminish, but how much cannot be determined.

Impacts on the Dillon Reservoir aquatic ecosystem are not quantifiable at this time due to a lack of baseline information.

SOILS

Construction of the Foothills Project at 125 mgd would increase soil erosion and sediment yields during the three years of construction and during the first seven years of operation. Table 5-1 summarizes these increases after mitigation. During this ten-year period, about 397.5 tons (0.205 acre-feet) of sediment would flow into the South Platte River; east of the foothills, a total increase of 1,355.1 tons (0.700 acre-feet) would be produced from disturbed areas. Water quality and aquatic habitat would be affected. The loss of 1,752.6 tons (0.905 acre-feet) of soil from 314 acres in the 125 mgd development area would not reduce long-term productivity noticeably. Soil productivity on 95 acres inundated by the dam and reservoir and 76 acres covered by roads, buildings, and major structures would be lost.

Expansion of the Foothills Project to 500 mgd would increase soil erosion and sediment yields between 1983 and 2001. The approximate yield would be 2735.7 tons (1.4 acre-feet) and would not reduce long-term productivity noticeably on the 509 acres impacted.

TABLE 5-1

INCREASED SEDIMENT YIELD IN TONS AFTER MITIGATION

Action	Acres Affected	Present Annual Sediment Yield	Increased Sediment Yield by Year										
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Total
Vegetation clearing	24	15.0	60.0	60.0	60.0								180.0 (0.093 acre-feet)
Reservoir by-pass	1					2.5	2.0	1.5	1.0	0.5	0		7.5 (0.004 acre-feet)
New Trail and road upgrading	28	14.0	70.0	56.0	42.0	28.0	14.0	0					210.0 (0.109 acre-feet)
East portal Access road	3	1.5	7.5	5.0	2.5	0							15.0 (0.008 acre-feet)
Portal access staging and ponds	8	4.0	20.0	20.0	20.0	13.4	6.6	0					80.0 (0.041 acre-feet)
Treatment plant complex Treatment plant site at 125 mgd	135	67.5	167.5	167.5	175.0	116.9	58.1						685.0 (0.354 acre-feet)
Treatment plant site at **500 mgd**	90	45.0	112.0	112.0	117.0	78.0	39.0						458.0 (0.229 acre-feet)
Sub-Total at 125 & 500 mgd	225	112.5	279.5	279.5	292.0	194.9	97.1				Sub-Total		1143.0 (0.583 acre-feet)
Conduit No. 26 and Aurora intertie	10	5.0	25.0	16.7	8.3	0							50.0 (0.026 acre-feet)
Conduit No. 27 (350 mgd only)	105	52.5	262.5	175.4	87.2	0							525.1 (0.271 acre-feet)
Second Parallel Conduit	105	52.5	262.5	175.4	87.2	0							525.1 (0.271 acre-feet
											Grand Total		2735.7 (1.4 acre-feet)

GEOLOGY, MINERALS, AND TOPOGRAPHY

Excavation of the dam foundation and abuttments would change the existing topography. The excavation would be filled with concrete and the existing natural topography would be replaced by a 243-foot high concrete dam. This change would secondarily affect aesthetics, recreation, and access in Waterton Canyon. The reservoir would inundate geologic, mineral, and topographic features upstream from the dam and below the 6,002-foot spillway elevation. All of the existing features would be lost from view. The geologic features are very similar in much of the Platte Canyon so the loss associated with building the dam would not be significant. However, aesthetic values would be affected. Speculative prospecting for uranium or pegmatite mineral deposits on 95 acres within the confines of the proposed reservoir would be impossible during the 75-year life of the proposed project. The sand and clay deposits in the area of the treatment plant would be lost. The value of these deposits is very slight based on current economics.

The Stevens Gulch staging area would require the leveling of four acres of land. Here, the gentle slopes of the natural topographic surface would be flattened; gross changes in topographic elevation would probably be less than 25 feet. At the treatment plant site and at the quarry disposal site excavation, grading and filling would alter the existing land form which would affect aesthetic values.

TERRESTRIAL RESOURCES

Construction of the reservoir and ancillary facilities in the Waterton Canyon would destroy 124 acres of vegetation, 108 of which would be permanently lost to production because of inundation, permanent roads, and the reservoir by-pass trail (Table 5-2). The vegetation losses would significantly affect terrestrial habitat, sediment yields, and water quality.

The permanent loss of 25 acres of riparian habitat would be partially offset by a gain of twelve acres of riparian vegetation which would naturally establish along portions of the shoreline and one acre of

TABLE 5-2

UNAVOIDABLE VEGETATION DISTURBANCE DURING LIFE OF FOOTHILLS PROJECT

Area	Acres Disturbed Permanent	Acres Disturbed Temporary	Temporary Disturbed (Time)	Years Required for Revegetation 1/	Total Acres
Reservoir	95	0	(2 yrs.)	5	95
By-pass trail	2	1	(2 mos.)	5	3
Stevens Gulch access road	5	5	(5 mos.)	5	10
Dam crest road	2	2	(5 mos.)	5	4
Dam base road	3			5	3
Road above reservoir	1	1	(5 mos.)	5	2
Concrete aggregate (impervious fill and topsoil)	--	150	(2 yrs.)	5	150
Stevens Gulch portal and staging area	--	4	(2 yrs.)	5	4
East portal	--	30	(2 yrs.)	3	30
Tunnel	--	--	--	--	--
Treatment plant complex (non-irrigated) 125	65	76	(2 yrs.)	3	141
500	114	90	(2 yrs.)	3	204
Total	179	166			345
Treatment plant complex (irrigated)	--	4	(2 yrs.)	1	4
Power & Telephone lines and roads	--	5	(6 mos.)	0	5
Conduit No. 27 and 2nd Parallel Conduit (native vegetation) 125	--	85	(3 mos.)	3	85
500	--	85	(3 mos.)	3	85
Total		170			170
Conduit No. 27 and 2nd Parallel Conduit (cropland) 125	--	20	(3 mos.)	1	20
500	--	20	(3 mos.)	1	20
Total		40			40
Sludge disposal		5	(1 yr.)	3	5
Total	287	583			870
SUMMARY BY VEGETATION ZONE					
Riparian zone	14	5		5	19
Montane zone	94	13		5	107
Grassland zone (native)	179	521		3	700
Grassland zone (cropland)	--	40		1	40
Grassland zone (irrigated)	--	4		1	4
Total Acreage	287	583			870

1/ When applying reclamation measures to temporarily disturbed areas.

riparian vegetation which re-establish in Stevens Gulch in about five years. A net loss of four acres of riparian vegetation would occur. It is possible that mitigation measures applied to riparian vegetative zones would not result in the success indicated; however, it is relatively certain that these areas would regain productivity in five to ten years.

The significant adverse impacts on wildlife species in the entire Platte Canyon would occur from human harassment and illegal killing of wildlife, especially during construction of the dam, tunnel, and roads. The smaller, less mobile species such as rodents and reptiles would not be able to relocate in other areas and would be lost because of the lack of unoccupied niches. Larger, more adaptable species such as deer, sheep, bear, and foxes could probably shift to less intensely disturbed areas. Loss of wildlife would reduce aesthetic and recreation values. After construction, most species would return to the areas temporarily disturbed and little net loss of biomass would occur.

For three years, noise and other construction associated with the 125 mgd development would drive some Bighorn sheep out of the lower sections of the canyon along the stream and would force them to concentrate away from the intense activity. The total impact of all sources could be the loss of as much as 50 percent of the herd. It is possible that the entire 60- to 65-head herd could be lost as a result of this project, but it is more probable that it would diminish to 30-head, the level reached during the construction of the South Platte intake. The loss of Bighorn sheep would reduce recreation and aesthetic resources in Waterton Canyon, probably affecting 5,000-6,000 recreation visitors to the canyon.

Disturbance of the riparian habitat along the North Fork as a result of higher flows could reduce the essential feeding area of the peregrine falcons enough to cause abandonment of the nesting site by the pair and possible loss of the falcons.

Deer, mountain lions, and black bears would be disturbed and driven from Waterton Canyon and Stevens Gulch by construction activity. Because their present numbers are low, impacts on them would not be serious, provided that adjacent habitat is available.

Construction of Conduit No. 27 and the second conduit parallel to it would temporarily disturb 85 acres of grassland vegetation and 20 acres of cropland, bisect two prairie dog colonies and possibly dislodge

antelope temporarily from part of 3,000 acres (approximately eight percent) of their range, north and west of the conduit near the Highlands Ranch (Map 2-7), for a period of about ten months. The impact on these species would be very slight and temporary. The few prairie dog burrows which would actually be excavated (approximately 100) would be less than 0.1 percent of the burrows in the general area.

CLIMATE AND AIR QUALITY

Construction of the plant at 125 mgd and 500 mgd would produce dust and vehicle emissions that would affect the Foothills area. Watering of disturbed areas and use of chemicals to hold down road dust should limit increases in dust in Waterton Canyon to an immeasurable amount. Air quality would not suffer as a result of the operation and maintenance of any part of the proposed project.

Emissions would increase during peak activity in construction (six months each for two consecutive seasons), of the 125 mgd plant and its expansion to 500 mgd. Such increases would not be expected to have a measurable effect on human health or vegetation in the primary impact zone. Increases in fugitive dust owing to construction of the proposed treatment plant complex, and Conduit No. 27 and the second parallel conduit are unquantifiable.

An accidental ammonia or chlorine spill would seriously degrade air quality in the vicinity and downwind of the spill. Residents in the area would probably have to be evacuated. The probability of such an accident is quite small, however.

NOISE

Construction within Waterton Canyon would raise noise levels from 32 to 60 decibals, adjusted (dBA) at 50 feet from the equipment. Birds and animals in the canyon and foothills would be adversely affected by the blasting to be done, although this cannot be quantified. Some of this noise would also be audible in the Kassler Treatment Plant area and possibly at Roxborough Park. Although blasting would be periodic and infrequent, it would reach an estimated 105 to 125 dBA at the source (DWB 1974).

After completion of the dam and reservoir, the sound level in the reservoir area would be diminished from 60 to 50 dBA. Water discharge from the dam's regulating valves would cause a continuously loud noise ranging from 85 to 95 dBA near the dam. Estimates are that 4,000 feet downstream this would be diminished to 60 dBA. Although this noise would have a significant impact on recreational use immediately adjacent to the dam, the problem would not be significant downstream from Stevens Gulch.

The equipment to be used in construction of both the 125 mgd and 500 mgd facilities is similar to that which would be used in the canyon. The noise levels generated by this machinery range from 85 to 95 dBA at 50 feet. The Roxborough Park community would probably receive levels of about 50 dBA. However, construction noise would vary during the various building periods.

Equipment used in laying Conduit No. 27 and the second parallel conduit would generate noise levels of 80 to 88 dBA. This sound level is considerably higher than existing levels and would create a temporary disturbance in the developed residential areas, but owing to the relatively short time involving any one location and the presence of other similar activities, impacts would not be significant.

VISUAL RESOURCES

As indicated in Chapter 4, few of the anticipated visual impacts of the proposal could be reduced or minimized through practical mitigation efforts. The visual contrasts remaining after mitigation comprise the adverse impacts which cannot be avoided.

Inundation and Increased Stream Flows

Inundation in the Waterton Canyon behind the Strontia Springs Dam would radically change the landscape. Instead of a narrow, steep-walled, rocky canyon with the South Platte River dominating the landscape, there would exist a placid lake with steep, rocky hills along its shoreline. The strong sense of enclosure would be relatively unchanged at the west end of the reservoir, but much weaker near the damsite.

As additional water is diverted from Dillon Reservoir, the mud flats will increase in size. This would cause an unsightly change in the land

form element of scenery and create a stark contrast to the existing shoreline vegetation. Visual impacts greatly in excess of visual management class limits are anticipated.

Although this would constitute a radical change, the resulting landscape would also be pleasing to the eye. The anticipated drawdown is so little that it should not have a significant effect on the visual integrity of the proposed shoreline.

Increased flows in the North Fork of the South Platte River would not have a significant visual impact on the landform unless significant stream bank erosion occurs (Figure 3-6). The degree of bank erosion that must occur to have a significant impact varies with the situation. For example, a five-foot high eroding bank may be significant within 100 feet of the associated sensitive feature and not significant 300 feet away. As a result, this impact is impossible to quantify in more than general terms.

The character of the river would be changed by raising the sustained flow. The unchannelized portion of the North Fork of the South Platte River would become a faster, more massive river during July, August, and September than has been seen in the past during the same time period. The varied shades of blue, green, and brown produced by the combined water depth, flow rate and channel characteristics of the river would be changed by the increased water flows. The resulting colors would be mainly shades of blue and green with little brown remaining. As a result, the visual and photographic variety of the river would be reduced. The periods of river flooding resulting from peak demand flows and sudden runoff from precipitation would intensify this impact. Figures 3-7 and 3-8 show areas expected to be flooded during peak flow periods.

Strontia Springs Dam

This part of the proposed action would impose a massive man-made feature on a relatively undisturbed landscape. As is illustrated by Figure 3-9, the dam would abruptly end the linear continuity of the Waterton Canyon. It would dominate the landscape due to its size and location.

The dam would produce high contrasts with the existing landscape in terms of landform, line, color, and texture, (the four basic elements used by the BLM to determine contrasts between proposals and the existing landscape.) Table 5-3 shows the comparison of the physical characteristics between the existing landscape and the proposed dam.

TABLE 5-3

VISUAL COMPARISON OF THE EXISTING LANDSCAPE AND THE PROPOSED STRONTIA SPRINGS DAM IN TERMS OF LANDFORM

Element	Existing	Strontia Springs Dam
Form	Jagged, blocky, enclosed corridor effect is strong	Flat, gently curved, wall-like, abruptly ending the visual corridor
Line	Angular with very strong convergence, broken ridgeline	Vertical and horizontal linear grid on face, horizontal linear top, smooth concavity on face, strong convergence
Color	Dark grey, black, green, red-brown	Light gray
Texture	Coarse	Smooth

The contrasts shown in Table 5-3 are evident at Cheesman Dam (Figure 3-10). Although more vegetation is present and the face of Cheesman Dam is stone masonry, the impact would be similar.

Although this structure generates a visual contrast generally considered to be too high by BLM standards, such a structure is both graceful and impressive. Its construction would still, however, destroy the natural landscape within its view.

Dam Crest Road

This road would not be entirely visible from Waterton Canyon floor or reservoir surface. It would be plainly visible, however, where it enters the visual corridor. At that point it would be a linear, cleared scar traversing a timbered steep slope on a prominent part of the canyon wall (Figure 3-11). Because the road would be above the point of observation, the road bed itself would not be visible.

Road Widening

Visual impacts of the proposal would be viewed from the existing access road in Waterton Canyon. Because of this, modifications of the existing road that create visual impacts would be very evident and likely to dominate in the foreground. As shown in Figure 3-12, a road with a 22-foot driving surface and associated cut into the rocky canyon wall results in high impacts on the landform in terms of form and color, and moderate impacts on line, created by both the rock and soil cuts and the significantly larger road. The anticipated impacts for the road widening proposals are shown in Table 3-13. An example of the existing road proposed for widening is shown in Figure 3-13 and can be compared with the existing 22-foot standard road, (Figure 3-12).

Staging Area

Staining the exposed concrete and painting all other structures a color compatible with the surrounding landscape would significantly reduce the anticipated color contrasts. As shown on Table 5-4, the remaining visual contrast would still be higher than the visual management class maximum contrast limit for that area.

Power and Telephone Lines

Construction of a combined power and telephone line to the damsite would generate high visual impacts from the structural standpoint (Table 5-5). This impact would be caused mainly by the imposition of a structure with strong linear characteristics on a landscape that has no such structure presently visible (Figure 3-15).

Foothills Treatment Plant

Construction of the treatment plant would impact the existing landscape, converting a presently undeveloped, sloping tract of land, shown in Figure 2-4, to a partially leveled tract covered with structures, asphalt, and formal landscaping (Figures 1-11).

As indicated on Table 3-12, the visual contrast levels anticipated to occur during construction would be in excess of visual management contrast limits from the structural standpoint, but not in terms of landform or vegetative pattern.

TABLE 5-4

ANTICIPATED VISUAL IMPACTS BEFORE AND AFTER MITIGATION
(CONSTRUCTION PHASES)

Rated Elements	Anticipated Visual Contrasts before Mitigation			Anticipated Visual Contrasts after Mitigation (Residual)			Visual Mgt Class Maximum Contrast Limit Contrast Limit
Foothills Treatment Plant	23	18	27	23	18	27	24
Conduit No. 27	22	20	18	22	20	18	24
2nd Parallel Conduit	22	20	18	22	20	18	24

Impacts on landform would mainly be in terms of form. Extensive leveling would occur in the area where buildings would be constructed. However, the present landform is relatively flat with gently rolling terrain, so the contrast is considered moderate rather than high.

As shown on Table 5-5 visual contrasts concerning vegetative patterns would be in excess of visual management class limits. This is due to the addition of shapes foreign to the vegetative patterns: structures, asphalt covered areas, and form landscaping. In addition to the shape of the formal landscaping, the grass, shrubbery, and trees are completely out of character for the existing landscape (Figures 1-11 and 2-4) and the contrast would be high since no other formal landscaping is within view and no trees are found on or near the plant site (on the plains physiographic area).

Conduit No. 27 and Second Parallel Conduit

As inaicated in Tables 5-4 and 5-5, this part of the proposal would not produce excessively high visual impacts. The area has low sensitivity because there are a number of existing intrusions: the Aurora Conduit and Conduit No. 85, suburbs, railroads and a highway. Because of this, the anticipated impacts of both conduits are relatively small.

CULTURAL RESOURCES

Archaeological Resources

Construction of the treatment plant complex, Conduit No. 27, and the second parallel conduit could have extensive impact on archaeological resources. The lithic material noted as occurring generally over the plant site area and buried or undiscovered sites would be destroyed, removed or scattered. Impacts on both known and as yet undiscovered archaeological resources could be of major significance.

Historic Resources

Several sites within Waterton Canyon would be lost. Keystone Bridge would be damaged whether removed or left in place. Also lost would be 2.6 miles of DSP&P modified railbed to the damsite, about 1.7 miles of Denver and Rio Grande Railroad rockwork on the south side of the canyon, the Deansbury Station and Strontia Springs sites, the telegraph

TABLE 5-5

ANTICIPATED VISUAL IMPACTS BEFORE AND AFTER MITIGATION
(YEAR 2001)

Rated Elements	Anticipated Visual Contrasts before Mitigation: Landform	Vegetative Patterns	Structure	Anticipated Visual Contrasts after Mitigation (Residual): Landform	Vegetative Patterns	Structure	Visual Mgt Class Maximum Contrast Limit: Contrast Limit
Flooding and Increased Stream Flows	7-13 2/	12	N/A	7-13 2/	12	N/A	16 1/
Strontia Springs Dam	30	N/A	30	26	N/A	26	16
22-Foot Standard Dam Crest & Road	17	20	N/A	17	20	N/A	16
22-Foot Standard Road Widening	25	18	N/A	13	13	N/A	16
12-Foot Standard Road Widening	23	N/A	N/A	13	13	N/A	16
Stevens Gulch Staging Area	17	10	21	17	10	17	16
Foothills Treatment Plant	12	27	25	12	27	21	20
Conduit No. 27	13	10	7	13	10	7	20
2nd Parallel Conduit	13	10	7	13	10	7	20

1/ 20 in Class IV areas.

2/ Higher figure assumes significant bank erosion.

poles in the floodpool area and the modern railroad bridge above Deansbury Station site.

The loss of these sites can be minimally mitigated through a general program of recordation, prior to destruction. However, an opportunity for future study would be lost because the physical remains would be totally destroyed.

Paleontological Resources

Excavations at the treatment plant complex, and along Conduit No. 27 and the second parallel conduit could encounter and disturb common fossils and other materials of paleontological interest as well as unknown or buried archaeological and historical sites.

The destruction or removal of historical, archaeological, or paleontological resources would affect recreation, aesthetic, and scientific values.

RECREATION

Construction activities associated with the dam and the reservoir would alter or permanently destroy many of the unique and impressive natural recreational characteristics in Waterton Canyon. Habitat for wildlife would be lost and decreases in the numbers and species, especially Bighorn sheep, would occur. The quality of any subsequent recreational experiences would then be decreased to the degree this wildlife did not return to the area after the completion of construction.

Closure of the canyon downstream of the reservoir area for three years would result in a loss of at least 18,000 high-quality recreational visits. These losses would probably be absorbed by other recreational resources along the eastern foothills of the front range.

Building the dam and reservoir and upgrading roads would bring about the loss of the remnant features of the narrow gage railroad and end any future consideration of it for tourism and recreation purposes.

Trout fishing opportunities would be eliminated on 1.7 miles of stream. These opportunities would be replaced with reservoir bank fishing. The brown trout fishery would be converted to one dominated by non-game fish. This change would not mean a loss of total fishing opportunity, but would mean a change in value.

At least initially, the dam and reservoir would attract larger numbers of people than now frequent the area, thus decreasing opportunities for solitude, increasing littering and trampling of the resource, and possibly driving out those species of wildlife that cannot abide frequent contact with humans. The North Fork of the South Platte River would continue to diminish as a recreational resource with increased flows. Higher flows would also create an increasing hazard to the safety of recreationists.

The quality of recreational experiences in the future Roxborough State Park and of occasional sightseeing and driving for pleasure would decrease with the coming of greater numbers of people, traffic, and noises associated with construction at the treatment plant area. As other intensive developments encroach on the area in the future, the impact from the treatment plant would diminish.

As additional waters diverted from Dillon Reservoir through Roberts Tunnel increase, the annual drawdown of the reservoir at 500 mgd will reach about 44 feet, creating large mud flats that will hinder boat launching and fishing access. How much this will reduce recreation use cannot be quantified.

LAND USE

If approved, the right-of-way for the dam and reservoir and roads in Waterton Canyon would be senior rights against any subsequent applications for use authorizations on public (BLM) and national forest lands. The dam and reservoir would commit more than 38 acres of Federal lands to this single, primary use.

Construction and operation of the proposed Strontia Springs Dam and Reservoir would permanently convert 117 acres (below maximum pool level) from present and future forest and woodland use to a municipal and industrial water diversion use. In addition, roads would occupy an additional nine acres of forest and woodland in both the present and future. Another eight acres of forest and woodland would be disturbed by road construction; the disturbance would last for about five years. Four acres in the Stevens Gulch area would be used for construction purposes for about three years and would take another five years to regain their original productivity for forest and woodland use.

The proposed facilities in Waterton Canyon would restrict traffic downstream from the dam and reservoir area to that associated with construction during a three-year period, limiting the multiple uses of that portion of Waterton Canyon.

Thirty acres of grazing land around the east portal and staging area would be used for construction of the 125 mgd plant for about three years. One animal unit would be lost each year.

Construction of the treatment plant facility at the initial 125 mgd capacity would disturb 135 acres for a three-year period. Of this, 65 acres would be permanently occupied by structures and lost to other uses. Security fencing around the facilities would enclose about 255 acres, effectively closing them to uses other than open space. Incremental addition of plant units such as flocculation and sedimentation beds, clear water reservoirs and sludge drying beds to attain 500 mgd capacity between 1983 and 2001 would eventually occupy an additional 49 acres within this fenced area, with temporary disturbance of as much as 90 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing and would remain as open space. About 320 acres which would have supported ten cows would be lost to grazing.

Construction of Conduit No. 27 would disturb about 105 acres of grazing land for three years until fully revegetated and would disturb about 20 acres of cropland (probably small grains) for not more than one growing season. When the plant complex is expanded to treat 500 mgd, at least one additional large-capacity conduit, capable of carrying at least 350 mgd, would be buried alongside Conduit No. 27 within the existing DWB right-of-way, causing temporary surface disturbance of approximately the same 105 acres that would be involved in placement of the initial conduit, with about the same temporary impacts.

The vehicle traffic affected would be rerouted or at least restricted to half the available roadway. The greatest inconvenience would be to users of South Colorado Boulevard and South Holly Street, where Conduit No. 27 and the second parallel conduit would be laid in the street for more than one mile each. The impact of construction for the second conduit would be greater, but it is not quantifiable.

During 125 mgd project construction daily traffic volumes would be increased from 7,999 vehicles per day to 8,300 vehicles per day on Colorado State Highway 75 between Wadsworth Boulevard and Kassler. The slight increase would not be noticeable.

Expansion to 500 mgd capacity and construction of the second conduit would add about 15 cars per day one way to local traffic for seven years, between 1983 and 2001. This impact is considered to be insignificant.

SUMMARY OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Following is a summary table of adverse impacts which cannot be avoided (Table 5-6).

TABLE 5-6

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Socio-Economic	1. Accidents: 43 during 3 years of construction.	1. Accidents: 35 general construction accidents and 53 motorized transport accidents during construction of additional increments; 20 motor vehicle accidents during life of project; chlorine accidents 1 each 11 years; ammonia accidents 1 each 22 years.
	2. Employment and Manpower: layoff of 460 construction workers after 3 years.	2. Employment and Manpower: layoff of undetermined number of construction workers after each completed increment.
Water Resources	1. Surface Water a. 83,300 acre-feet per year would be diverted from Blue River watershed through Roberts Tunnel in 1990.	1. Surface Water a.
	b. Strontia Springs Dam would create a new 95-acre reservoir in place of 1.7 miles of river.	b.
	c. Strontia Springs Diversion Dam would divert up to 193 cfs. Flows would average 60,500 ac-ft per year less than 1964-73 annual average of 298,000 ac-ft.	c.
	2. Water Quality a. Additional Dillon diversions would deplete flow of Colorado River.	2. a.
	b. Salinity would increase: Cameo, Colorado now 440 mg/l would increase by 11 mg/l; Imperial Dam, Arizona now 861 mg/l, would increase by 7 mg/l.	b.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Water Resources (cont.)	c. 447 tons (0.23 ac/ft) of sedimentation would be added to South Platte River during 3 construction years.	c.
Aquatic Resources	1. 1.7 miles of South Platte River would be converted into 1.7 miles of reservoir, suitable spawning areas will be lost, plus 1 amphibian pond.	1. Increased flows would cause unquantifiable bank erosion, and destroy 20 miles of riparian vegetation, which would destroy unquantifiable aquatic and terrestrial habitat and reduce fish crop.
	2. 10% reduction in surface area in 2.6 miles between Strontia Springs Dam and South Platte Intake; however, aquatic productivity would increase with adequate flows.	2.
Soils	1. Soil erosion and sediment yields would increase in 3 years construction and 7 years of operation; 397.5 tons (0.205 ac-ft) of sediment into Platte River, and 1.355 tons (0.700 ac-ft) from disturbed areas eastward.	1. Soil erosion and sediment yields would increase between 1983-2001 approximately 2,735.7 tons (1.4 ac-ft) and would not noticeably reduce productivity long-term on 509 acres impacted.
	2. 314 acres of soil (1,743 tons) would not reduce long-term productivity; 95 acres inundated and 76 acres covered by construction would lose productivity.	2.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED (cont.)

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Geology, Minerals, and Topography	1. Concrete dam and excavation would change topography.	1.
	2. Reservoir would inundate upstream and below the 6,000-foot spillway.	2.
	3. Speculative prospecting on 95 acres of the reservoir would be lost.	3.
	4. Sand and clay deposits would be lost.	4.
	5. 74% (52,000 tons) of sediment from the river would be deposited in the reservoir; waters leaving would only carry away 26% of that amount.	5.
	6. 300,000 tons of aggregate would be excavated for construction.	6.
	7. 4 acres would be leveled for Stevens Gulch staging area.	7.
Terrestrial Resources	1. Vegetation: 108 of 124 disturbed acres would be lost by construction. 14 acres of riparian vegetation would be lost, but probably return to productivity in 5-10 years.	1.
	2. Wildlife: harassment, illegal killing, noise would all disturb wildlife ana some would be lost (unquantifiable); some would return after construction is complete.	2.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED (cont.)

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Terrestrial Resources (cont.)	a. Bighorn sheep: probably 50% reduction from construction to 30-35 head, affecting 5,000-6,000 recreation visitors to the canyon.	
	b. Disturbance of riparian habitat by higher flows could cause abandonment of Peregrine falcon nest.	
	c. Deer, mountain lions, and bear would be driven out, but they are few.	
	3. Conduit construction would disturb 85 acres of grassland vegetation, 20 acres of cropland, bisect 2 prairie dog colonies and dislodge antelope temporarily from 8% of their 3,000 acre range for 10 months. These impacts are not significant.	3.
Climate and Air Quality	1. Dust and vehicle emissions resulting from Foothills would be highest during construction, but are unquantifiable after mitigation of watering.	1. Dust and vehicle emissions resulting from Foothills would be highest during construction, but are unquantifiable after mitigation of watering.
	2. Ammonia or chlorine spills are unlikely, but would degrade air quality if they occurred.	2. Ammonia or chlorine spills are unlikely, but would degrade air quality if they occurred.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Noise	Construction would raise noise from 32-60 dBA and adversely affect wildlife and people. After construction the sound level would be reduced from 60 to 50 dBA. Construction equipment can range from 85-95 dBA at 50 feet away; however, sound level would lower after construction.	Construction would raise noise from 32-60 dBA and adversely affect wildlife and people. After construction the sound level would be reduced from 60 to 50 dBA. Construction equipment can range from 85-95 dBA at 50 feet away; however, sound level would lower after construction.
Visual Resources	1. Inundation would change the Waterton Canyon from a canyon to a placid lake; however, then radical change would not be displeasing.	1. Those visual elements which were part of the original 125 mgd construction would remain the same contrast, lessened only by their relative absorption into existing surroundings. For new visual elements resulting from construction for the additional increments, the classification would be greater in impact. Since those impacts have already been generated, the anticipated impacts of both conduits are relatively small.
	2. According to BLM's Visual Management Classification, construction elements would present the greatest contrast to the existing environment (Tables 5-4 and 5-5).	2.
	3. Strontia Springs Dam would impose a man-made feature on a relatively undisturbed landform, not necessarily an adverse impact.	3.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Visual Resources (cont.)	4. The color, flow and character of the river would change.	4.
	5. The Dam Crest Road would be a visible linear scar.	5.
	6. Road widening would result in high impact in form and color.	6.
	7. The staging area would result in high impact from a color standpoint.	7.
	8. Power and telephone lines would result in high structural impact.	8.
	9. The Foothills Treatment Plant would highly impact the landscape in excess of visual management contrast limits from a structural as well as vegetative standpoint.	9.
Cultural Resources Archaeological Resources	Construction would bury, destroy, or remove archaeological resources both known and unknown.	Construction would bury, destroy, or remove archaeological resources both known and unknown.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Historical Resources	The following sites would be lost: Keystone Bridge, 2.6 miles of DSP&PRR roadbed, 1.7 miles of D&RGRR rockwork, Deansbury Station and Strontia Springs site, telegraph poles in the floodpool, and the modern railroad bridge. Any opportunity for future study would be lost.	The following sites would be lost: Keystone Bridge, 2.6 miles of DSP&PRR roadbed, 1.7 miles of D&RGRR rockwork, Deansbury Station and Strontia Springs site, telegraph poles in the floodpool, and the modern railroad bridge. Any opportunity for future study would be lost.
Paleontalogical Resources	Excavations would encounter and disturb paleontalogical resources.	Excavations would encounter and disturb paleontalogical resources.
Recreation	1. Habitat for wildlife and numbers of wildlife would decrease.	1.
	2. 18,000 recreational visits would be lost during construction.	2.
	3. The narrow gage railroad would be lost.	3.
	4. 1.7 miles of stream trout fishing would be replaced by bank fishing.	4.
	5. The dam would attract visitors (and increase litter).	5.
	6. Higher flows would decrease safety for recreationists.	6.
	7. People, traffic, and noise would reduce recreation quality.	7.
	8. Mudflats would increase from drawdown in Dillon Reservoir.	8.

1/ Where blank spaces occur, no impact could presently be assessed.

TABLE 5-6

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED (cont.)

Environmental Element	Impacts at 125 mgd	Impacts at 500 mgd 1/
Land Use	1. 117 acres would convert from forest to water diversion use.	1. Addition of incremental plant units would occupy an additional 49 acres, with 90 acres temporarily disturbed; 65 acres would remain as open space; 320 acres would be lost to grazing.
	2. Roads would occupy 17 acres.	2. Construction of Conduit No. 27 would disturb 105 acres of grazing land for 3 years. The same acres would be disturbed when the additional parallel conduit is built.
	3. 4 acres in Stevens Gulch would be disturbed for 3 years and would take 5 years to recover.	3.
	4. 30 acres of grazing land would be used for construction.	4.
	5. 135 acres would be disturbed for 3 years of construction, and 65 acres would be lost to structures.	5.
	6. Security fencing would enclose 255 acres.	6.
	7. Vehicle traffic would be restricted in construction area. Volume of traffic would increase from 7,900 to 8,300 vehicles per day on Highway 75.	7. 15 cars would be added per day between 1983 and 2001.

1/ Where blank spaces occur, no impact could presently be a

CHAPTER 6

THE RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

This chapter discusses productivity of the environment which would be affected by the construction and operation of the proposed Foothills Project. In this context, "short-term" refers to the three years required to construct the components of the Foothills Project at 125 mgd, and the three additional two-year construction periods necessary to bring the treatment plant to 500 mgd. "Long-term" refers to the estimated 75-year project life. Beyond 75 years, the dam and reservoir would probably continue to affect productivity, since the removal of this structure would not be practical. It is assumed that other aboveground, permanent facilities would be removed and partially salvaged and the affected areas reclaimed.

In total, about 580 acres of land in a naturally productive state would be disturbed during construction of the 125 mgd plant, of which 76 acres would be occupied by man-made buildings, roads, trails, and structures, and 95 acres of aquatic and terrestrial habitat would be transformed from stream to reservoir habitat. Uses on the remaining 409 acres would be modified temporarily or disturbed by short-term construction-related activities. An additional 309 acres would be disturbed during expansion to 500 mgd capacity.

The short-term uses on the 383 acres would reduce natural productivity during construction and a three- to five-year restoration period. During this time about 447 tons of vegetation would be lost. Long-term annual production thereafter would be unaffected. The occupation of 76 acres by structures would eliminate natural productivity; a long-term net loss of biomass during the 125 mgd construction phase and in the 500 mgd construction phase is not quantifiable.

Filling of the proposed reservoir would inundate 95 acres of terrestrial habitat and replace it with a relatively sterile aquatic habitat. Terrestrial biomass estimated at 4,000 tons would be lost during the 75-year project life, and since it would remain afterwards, the dam would continue to reduce biotic production about 42 tons annually thereafter. The short-term construction uses in Waterton Canyon would affect long-term land uses on 117 acres (to high-water line), by eliminating most land use options in the future. However, casual land uses such as recreational and wildlife use would continue. Of the 117 acres, 38 acres would be federally managed, and multiple uses would be restricted to uses associated or compatible with the primary purpose of water diversion.

The removal of vegetation and associated soil disturbances would increase sediment yield by 1,752.6 tons in the short-term construction and restoration period. As vegetation became reestablished, sediment production would stabilize at a near natural level. During the construction and restoration period, 397.5 tons of the additional sediments would be added to a 2.6-mile stretch of the South Platte River. The loss of about 35 head of Bighorn sheep would be associated with construction in Waterton Canyon. In the long-term, the herd would regain its present level of 60-65 head, and production would return to present levels.

Human interest values would be significantly impacted in both the short- and long-term. Closure of Waterton Canyon to public use during the three years of construction would eliminate 18,000 visits for recreation use and aesthetic enjoyment. Over the long-term and beyond, although the canyon would be re-opened to public use, the use would be changed from those opportunities associated with a free-flowing stream in a rugged, relatively untouched setting, to those associated with a setting dominated by the dam, reservoir, and other man-made facilities.

The local short-term use of the project area would entail disturbance within the area of the old DSP&P right-of-way and the old Denver and Rio Grande rockwork roadbed below the damsite.

Upstream short-term and long-term uses would be about the same. With increased flows, there would be short-term damage to certain historical sites within the North Fork Historic District. However, over the long-term, these impacts would be secondary in nature and would be relatively minor.

East of the Foothills Project site there would be a loss of opportunities to study undiscovered archaeological sites and paleontological resources. Although these cultural resources would be identified and recorded during construction, the options for future interpretation and study would be lost.

The landscape resulting from the proposal would be permanently altered. It would display more intrusions than at present, and would thus affect those who view it. The degree of scenic degradation would vary with the location of the viewer and would be directly related to the unavoidable impacts indicated on Table 5-4.

Although silt would be added during the short-term construction period, the proposed dam would trap 2,110 acre-feet of silt annually over the 75-year project life and reduce turbidity in 2.6 miles of the South Platte River below that point. This probable improvement in aquatic habitat would be more than offset by the reduction in flows in that area. Trout production would be reduced by 10 percent, or 95 pounds annually, for a total loss of 7,125 pounds of trout during the long-term (75-year) life of the project.

In the short-term, grazing use would be affected by construction on 350 acres and dry farm production would be affected on 20 acres. In the long-term, future land use on 610 acres would be affected. Of the 610 acres, 485 acres at the proposed treatment plant complex are presently grazing lands. At 125 mgd capacity, 65 acres would be occupied by structures. Security fencing around the facilities would enclose about 255 acres. Incremental addition of plant units to attain 500 mgd treatment capacity would eventually occupy an additional 50 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing, and would be open space.

The Denver Water Board (DWB) would expect to continue to lease their lands for livestock grazing, about 165 acres north of and outside the security fence. In the long-term, 105 acres of land within the DWB's existing right-of-way for proposed Conduit No. 27 and the second conduit parallel to it would be lost from possible development for residential use.

During the short-term construction period, the Foothills Project would use about 28.9 million kilowatt hours of electrical energy. In the long-term, however, the hydrogenerator would produce 11 million kilowatt hours annually at 125 mgd, and 78 million kilowatt hours at 500 mgd. The plant and dam operation would use 8 million kilowatt hours annually at 125 mgd, and 13 million kilowatt hours at 500 mgd. Over the life of the project, therefore, there would be a net gain of over 128.6 million kilowatt hours of electrical energy for sale and ultimate consumption with the plant operating at 125 mgd.

Assuming that the unemployment level among transportation and public utilities workers remains stable, the permanent work force needed to maintain the entire proposed project would reduce the unemployed transportation and public utilities labor force of 649 (Table 2-5) in the DBLMA by 5.4 percent, thus maintaining and enhancing the long-term productivity of 35 families.

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This chapter identifies the extent to which the proposed action would irreversibly diminish the range of potential uses of the land and its resources. In this context the term irreversible is defined as use that is incapable of being reversed; once initiated, it would continue. The term irretrievable means irrecoverable; once used, it is not replaceable.

Although the natural productive capacity of impacted land and water resources would be regained in the short-term or long-term, or after the 75-year project life, interim production would be lost. Those production losses, cited in Chapter 6, would be irretrievable.

The Denver Water Board (DWB) has constructed and is operating facilities which can provide a reliable raw water supply to Waterton Canyon of 206,000 acre-feet per year after losses. The commitment to use this water has been made, and construction of the Foothills Project at 125 mgd does nothing to modify that commitment. The expansion of the proposed Foothills Treatment Plant from 125 mgd to a capacity of 500 mgd to meet the max-day demands of the projected population will be concurrent with the development of additional sources of raw water to satisfy the annual demand of that population.

When and if such expansion occurs, additional water resources whether they originate in the Colorado River Basin or the South Platte River Basin, will be committed to use by users within the DWB service area.

Construction of the Foothills Project would require 450,000 tons of aggregate, 73,000 tons of cement, and 19,000 tons of steel. Except for possibly 5,000 tons of steel which could be practically salvaged, these resources would not be recovered and would be considered irretrievable.

The visual impacts identified as unavoidable in Chapter 5 constitute irreversible and irretrievable commitments of resources. From the practical standpoint, even if the entire project were abandoned sometime after construction, it would be nearly impossible to return the dam and reservoir area, all constructed roads, the staging area, Conduit No. 27, and the second parallel conduit, to a natural or quasi-natural state.

The dam and reservoir in Waterton Canyon would irreversibly change the 95 acres of aquatic and terrestrial habitat into reservoir habitat. Associated with the construction of the facilities will be the loss of 35 Bighorn sheep. Higher flows could reduce the falcons' feeding area enough to cause abandonment of the nesting site. The 18,000 recreation visits to the canyon would be irretrievably lost during construction.

Recreational use patterns and trends would be altered, and land use options not compatible with the dam's presence would be eliminated. Considering present technology this structure could not be practically removed; these effects, therefore, could not be reversed at any time in the foreseeable future.

The construction of the proposed project would cause all known or unknown archaeological, historical, and paleontological resources to be preserved only as data, destroyed, or removed from context. Although there may be other similar cultural sites and values at other locations, the loss of these particular resources would be considered an irretrievable commitment.

Those sites within Waterton Canyon above the damsite will continue to be irreversibly and irretrievably committed as total losses. These sites include the DSP&P railbed, the Deansbury Station site, the Deansbury Bridge, and the D&RG railbed above the damsite. Below the dam, the Keystone Bridge would be totally lost, through the radical change of the canyon environment and massive modifications in the area.

Those sites along the North Fork of the South Platte River in the North Fork Historic District will not be irreversibly committed since they will not be lost.

There would be a good chance that buried archaeological and/or paleontological resources would be destroyed and lost at the treatment plant complex, and along Conduit No. 27 and the second parallel conduit; this commitment would be irretrievable.

The 65 acres which would be occupied by permanent structures at the treatment plant would lose their natural productivity for the life of the project, as would an additional 50 acres that would eventually be occupied by increments to attain the 500 mgd plant capacity. The right-of-way for Conduit No. 27 and the second parallel conduit, along with Aurora's adjoining right-of-way, would control future land uses. During the 75-year project life, the rights-of-way would result in residential or similar layout and design development in adjoining areas, to accommodate the restrictions against permanent structures within the right-of-way.

These developments would remain long after the life of the project, as would their layout and design features. It would be possible for adjoining uses to extend onto the right-of-way after 75 years; however, the adjoining developments would still control layout and design over the conduits. The developmental layouts and design would be irreversible.

A commitment of electrical energy would be associated with the construction and operation of the proposal. Construction would require about 28.9 million kilowatt hours; 8 million kilowatt hours annually, or a total of 667.5 million kilowatt hours, would be used over the 75-year project

life. This represents a total commitment of 696.4 million kilowatt hours of electrical energy. However, since those 8.9 million kilowatt hours would not be produced without the project, only the 28.9 million kilowatt hours lost to construction would be irretrievable. In summary, there would be a commitment of $133,539,000 in goods, services, and manpower over a three-year period for construction of the first increment of the proposed project. To complete the second, third, and fourth increments would require commitment of an additional $131,084,000 in physical and human resources by the 2001.

CHAPTER 8

ALTERNATIVES TO THE PROPOSED ACTION

Two categories of alternatives were considered: (1) major alternatives, which include options for no action and changes in structure and location, and (2) minor alternatives, which pertain to options regarding a single component of the project.

The alternatives are described and analyzed under the assumption that appropriate mitigating measures proposed in Chapter 4 would be applied to each alternative. Mitigated impacts of each alternative are described to the extent that the option differs from the proposed action. Table 8-1 compares impacts of the proposed action and the major alternatives.

Besides the alternatives analyzed, numerous other alternatives were considered but were rejected because they were not technically feasible or they would result in unacceptable environmental impacts.

In addition, an analysis is presented on alternatives for potential raw water sources. Although these are not a part of the proposed Foothills project and are not discussed elsewhere in the statement, they are appropriate to be included, because existing reliable water sources will be fully utilized during the life of the project.

MAJOR ALTERNATIVES

No Action

Description

Under the no action alternative, the Bureau of Land Management (BLM) would deny the right-of-way application for construction of the Strontia Springs diversion dam and reservoir, tunnel, and access road improvements.

Analysis

A rejection of the Denver Water Board's (DWB's) right-of-way applications would restrict expansions of its raw water diversion facilities in Waterton Canyon. As a result, it is assumed that the proposed Foothills treatment facilities and treated water conduit, as described in Chapter I of this statement, Proposed Action, would not be constructed.

TABLE 8-1

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVE

Area of Impact	Proposed Action	No Action	Upstream Alternative	Chatfield Alternative
SOCIO-ECONOMIC				
No. of jobs for 3 years	400 jobs	0	300 jobs	250 jobs
Water shortage days in 1990	0	40 days	0	0
2000	0	63 days	0	0
Date raw water becomes limiting factor	1988	1990	1988	1988
Electric energy (per year)				
At 125 mgd:	Produce: 11,000,000 kwh	0		0
	Use: 8,000,000 kwh	0	8,000,000 kwh	58,773,000 kwh 1/
	Surplus: 3,000,000 kwh	0		0
At 500 mgd:	Produce: 78,000,000 kwh	0		0
	Use: 13,000,000 kwh	0	13,000,000 kwh	216,066,000 kwh 1/
	Surplus: 64,000,000 kwh	0		0
WATER				
1988 average annual flow in the South Platte above the Platte Canyon intake	328 cfs	521 cfs	328 cfs	521 cfs
AQUATIC RESOURCES				
Miles of stream lost	1.7 miles	None	0.5 miles	None
Replaced by acres of reservoir	95 acres	NA	8 acres	NA
Geology, topography, and minerals	Speculating prospecting for iron, copper, or uranium would be impossible for at least 75 years.	None	None	None

1/ This does not include carbon regeneration.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVE

Area of Impact	Proposed Action	No Action	Upstream Alternative	Chatfield Alternative
SOILS				
Sediment yield (additional above present) for project life 125 mgd	1,752.6 tons	None	1,793 tons	1,175 tons
500 mgd	3,886.3 tons	None	3,926.7 tons	1/
TERRESTRIAL RESOURCES				
Vegetation permanently lost 125 mgd	193 acres	None	75 acres	65 acres
500 mgd	307 acres	None	189 acres	1/
Vegetation temporarily lost (3-5 years) 125 mgd	387 acres 1/	None	389 acres 2/	313 acres 2/
500 mgd	582 acres 2/	None	584 acres 2/	1/ 2/
Type of Bighorn habitat limited during construction	Summer range Winter range Lambing grounds Breeding areas	None	Summer range	None
Reduction on Bighorn population	From 60-65 to 30 head	None	From 60-65 to 45 head	None
Golden eagle eyries disturbed	One eyrie	None	Two eyries	None
Loss of habitat for other species in miles of canyon bottom	4 miles	None	8 miles	None

1/ Data not available for 500 mgd. for Chatfield.

2/ The second parallel conduit would redisturb a portion of these habitat acres; it is not quantifiable.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVE

Area of Impact	Proposed Action	No Action	Upstream Alternative	Chatfield Alternative
CLIMATE AND AIR QUALITY	Air quality in the construction area will be degraded by dust and vehicle emissions in amounts too small to measure	None	Same as proposed action	Same as proposed action
NOISE				
Intermittent noise levels in construction area	90 dBA	None	90 dBA	90 dBA
VISUAL RESOURCES				
Inundation and increased stream flows 125 mgd	Low	Low	Low	Low
500 mgd	Moderate	Moderate	Moderate	Moderate
Dam	High 1/	None	High 1/	None
Access roads	High	None	High	Low 2/
Staging area	High	None	None	None
Power and telephone lines	High	None	High 2/	Low 2/
Water treatment facility				
125 mgd	High 1/	None	High 1/	High 1/ 2/
500 mgd	Low	None	Low	Low 2/
Conduit No. 27				
2nd Parallel Conduit	Low	None	Low	Low 2/
Tunnel muck disposal	Low	None	High 1/	None

1/ Indicates a contrast in excess of BLM standards for the area and visual management class involved.

2/ Alternate location.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVE

Area of Impact	Proposed Action	No Action	Upstream Alternative	Chatfield Alternative
CULTURAL VALUES				
Archaeological features lost	Undiscovered features lost; cannot be quantified	None	Undiscovered features lost; cannot be quantified	None
Historical features lost	1.7 miles narrow gage railroad grade (DWP&P; D&RG, Deansbury Sta., Strontia Springs site, Keystone bridge)	None None	1/2 mile narrow gage railroad grade (DSP&P, D&RG)	None
Paleontological features lost	Undiscovered features lost; cannot be quantified	None	Undiscovered features lost; cannot be quantified	None
RECREATION				
Visitor days lost during construction	18,000 (3-year construction period)	None	40,000 (4-year construction period)	1.4 million (1-year construction period)
LAND USE				
Land use options lost	727 acres	None	588 acres	312 acres

Socio-Economic Implications

The no action alternative would result in the occurrence of peak day shortages about two years sooner than if the project were constructed. However, by 1990 and beyond, consumers in the DWB service area would experience an equal number of water shortage days with or without the project.

Table 2-33 shows that the ability of the DWB to deliver treated water would be constrained from the present through the end of the study period. This constraint would be caused initially by inadequate treatment plant capacity and would be intensified when the existing reliable annual raw water supply would be fully utilized in 1990 (Table 2-33).

Figures 8-1 and 8-2 show that part of the year when limited treatment plant capacity and limited raw water would necessitate an absolute reduction in treated water use.

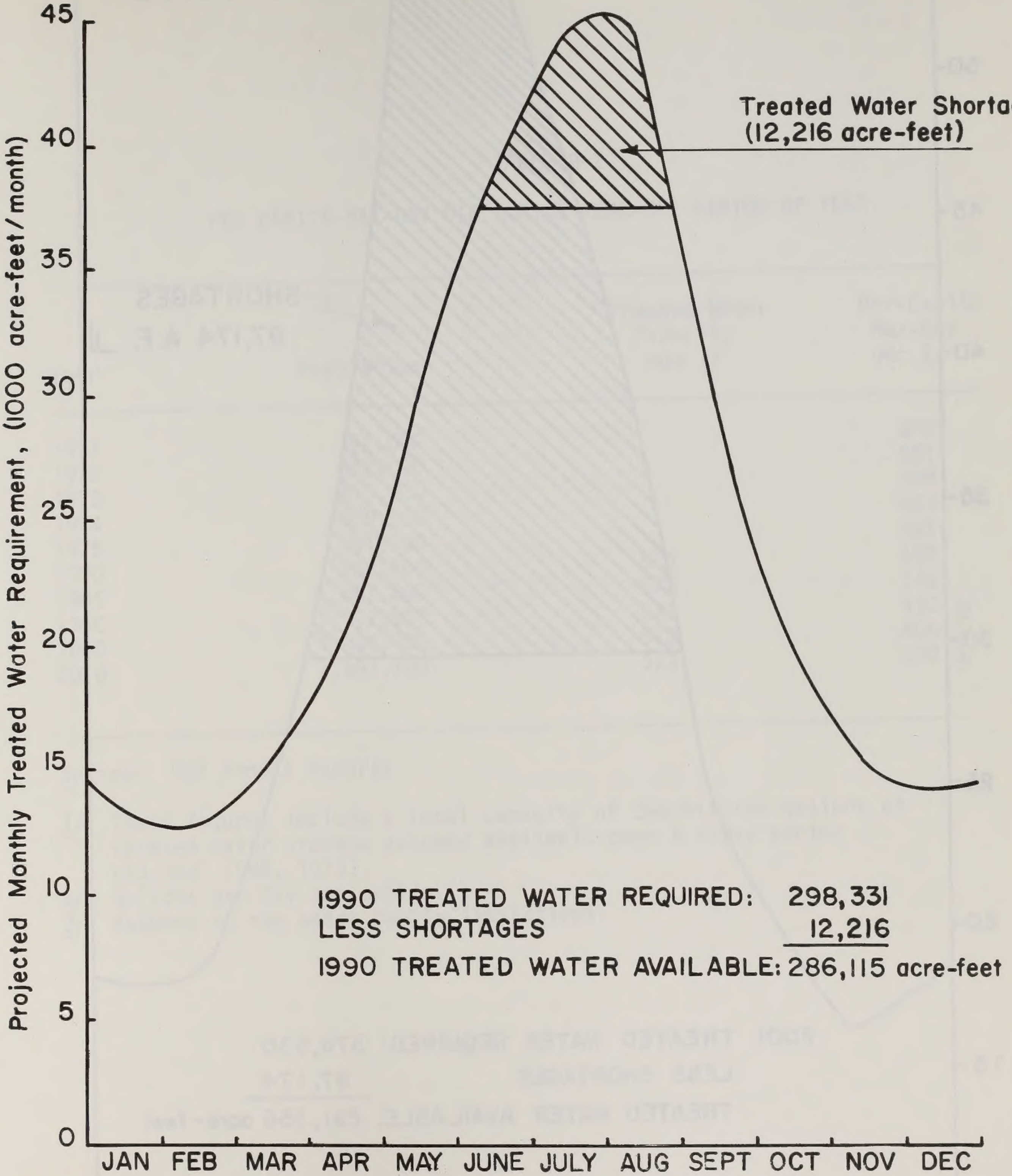
To minimize overtaxing the treated water system, water use restrictions would be mandatory. Such restrictions would be implemented early in the spring and carry through the fall. Overtaxing the system could cause negative pressure to develop, possibly resulting in the loss of fire-fighting capability and contamination within the treated water transmission system.

As the population within the DWB service area continues to grow, these water-use restrictions would become successively more stringent. Such restrictions would reduce per capita max-day use from the historical high of 608 gallons per day per capita (gdc) to 493 gdc by 1990 and 400 gdc by 2000. Table 8-2 shows the reduction in per capita max-day use as it would relate to the existing DWB treated water capability.

Another result of implementing water-use restrictions during peak-use periods would be a change in the monthly use pattern. Table 8-3 displays the historic, 1990, and 2001 percentages of annual water supply delivered or projected to be delivered by the DWB month by month. The table depicts the progressive decrease in summer peak-use as population continues to grow and makes demands on a system that has already reached the limit of its capabilities to provide treated water. If this trend were to continue, it would approach a situation in which customers would only be allowed the same amount of water every month, corresponding to the minimal, winter-use rate.

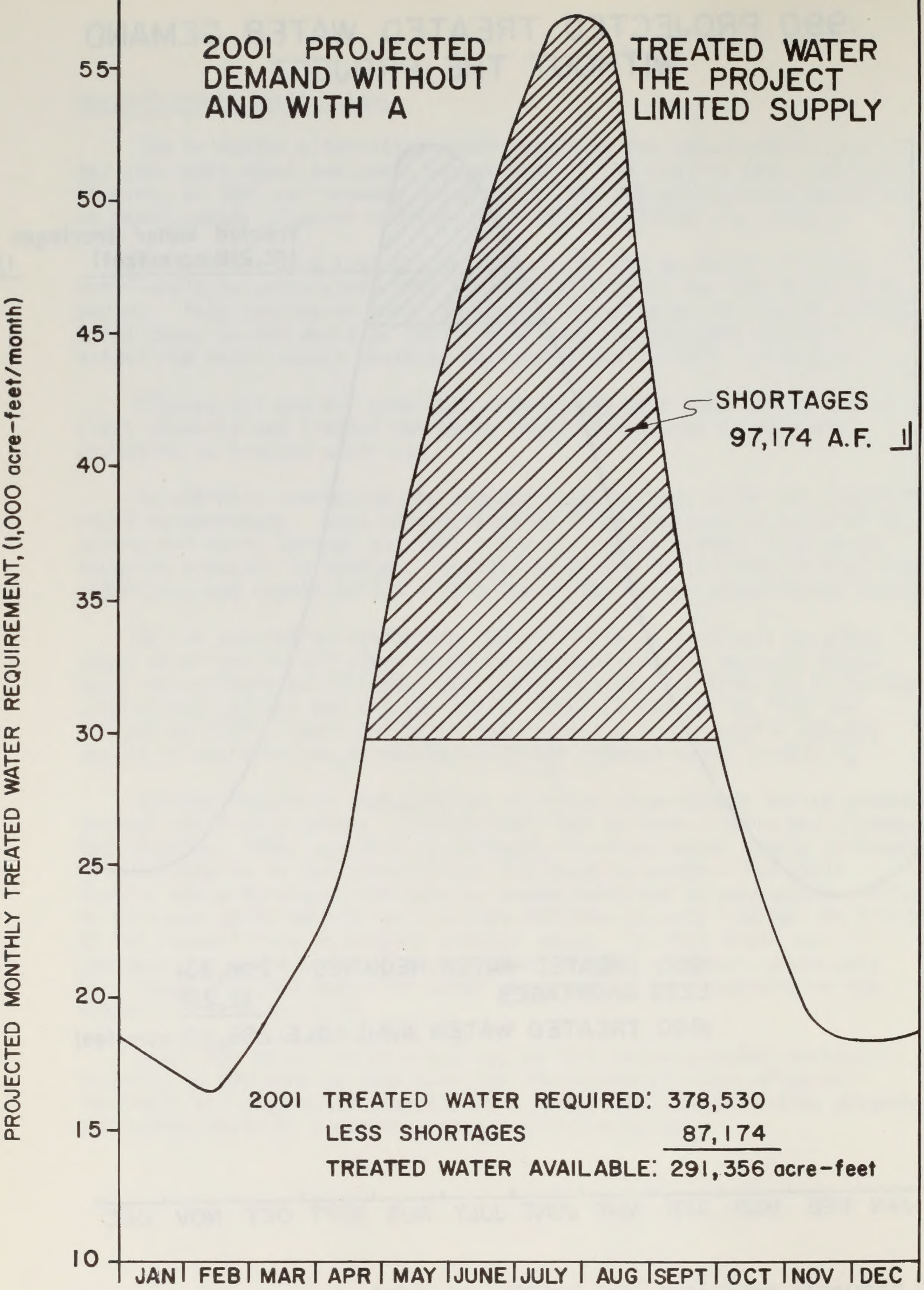
Under the no action alternative, certain socio-economic strategies could probably be employed to cope with the inevitable shortage of water. The first strategy would probably be a water rationing-education program, the second would be a conservation-education program.

1990 PROJECTED TREATED WATER DEMAND WITHOUT THE PROJECT



1/ Shortages predicated upon inability to satisfy treated water demand.

FIGURE 8-1



⅃ Shortages predicted upon inability to satisfy treated water demand

FIGURE 8-2

TABLE 8-2

PER CAPITA-MAX-DAY USE DURING PEAK-USE PERIOD OF YEAR

Year	Population	Treated Water Capacity mgd 1/	Per-Capita Max-Day gdc 2/
1971	792,000		578
1972	812,000		551
1973	833,000		608
1974	879,000		551
1975	891,000		561
1980	958,400	573	598
1985	1,057,200	573	542
1990	1,162,900	573	493 3/
2000	1,434,100	573	400 3/
2010	1,693,700	573	338 3/

Source: DWB Annual Reports

1/ These figures include a total capacity of 264 million gallons of treated water storage assumed available over a 5-day period (53 mgd) (DWB, 1973).
2/ Gallons per day per capita.
3/ Assumes no raw water supply limitations.

TABLE 8-3

PROJECTED MONTHLY PERCENTAGE OF THE ANNUAL WATER SUPPLY
DELIVERED BY THE DWB

Months	Historic Average 1965-1974	W/o Project 1990 1/	W/o Project 2001 1/
January	4.7	4.9	6.1
February	4.3	4.5	5.7
March	5.3	5.5	6.9
April	6.8	7.1	8.8
May	10.4	10.8	10.2
June	12.9	13.4	10.2
July	14.9	13.4	10.2
August	14.6	13.4	10.2
September	9.6	9.9	10.2
October	6.7	6.9	8.7
November	5.0	5.2	6.6
December	4.8	5.0	6.2

1/ Raw water supply available limited to existing supply (312,300 acre-feet).

Water Rationing-Education Program

A water rationing-education program would be the first strategy used, because it could be established almost immediately; in fact a minor water rationing project is in progress (spring 1977). A conservation-education project would require more time to institute.

Since water shortages would be inevitable in view of current levels of use during peak-use periods, it might be necessary to reduce per capita use to winter months' rates, especially during periods of extreme water shortage. At the current average winter months' use rate (117 gallons per day per capita), the present water supply system operating at 50 percent of capacity could support a population of 2,222,222 (520,000,000 gallons per day X 0.5 of present capacity ÷ 117 gallons per day per capita = 2,222,222 population). DRCOG's projected population for the year 2010 in the DWB service area is 1,673,700.

Establishing winter months' use rates throughout the year could be achieved by the water rationing-education strategy. For a major water rationing-education project a priority system would have to be established. High priorities for access to water will be assigned to:

1. Fire fighting;

2. Medical facilities (hospitals, nursing homes, doctors, etc.);

3. Public education facilities;

4. Institutions for the elderly, handicapped, and children;

5. Residential use (life functions).

Peak demand day shortages in the future would require that law enforcement personnel actively enforce emergency measures to ensure that high priority consumers such as fire protection and health agencies are not deprived of necessary water. These added responsibilities would necessitate using a larger proportion of the police force for regular patrols related to water usage. At the same time, via the education segment of the program, the public would be kept informed of the reasons why the program was necessary.

In order to enforce water rationing, the DWB has the power to add a $10.00 charge to a customer's water bill for the first violation of water rationing rules. Second-time violators at a metered building are advised in writing and a water restrictor is placed immediately in the service line. The restrictor is not removed until the customer pays a $50.00 special service charge. A subsequent violation results in reinstallation of the restrictor, and another $50.00 is charged for its removal. Second-time violators at a building with no meter (or a flat rate charge) are charged the cost of installing a meter, which is done

immediately. Subsequent violations are treated in the same manner as other metered customers.

A direct consequence of patrolling residential areas to restrict or cease irrigation for horticultural purposes would be, in prolonged periods of water shortage, severe damage to, or total loss of, the residential horticultural investment. In the event of a total loss, the economic impact in the six-county area is estimated conservatively at $1,127,674,000. This figure was arrived at by assuming that the average horticultural investment per dwelling unit is $2,000 and multiplying that by the number of dwelling units ($2,000 X 563,837 = $1,127,674,000) (Wieder, 1977). As pointed out in Chapter 2, the $2,000 horticultural investment figure takes into account smaller plots in Denver county and multiple dwellings throughout the six county area, as well as parks, golf courses, and highway medians.

The Constitution of the State of Colorado assigns industry the lowest priority for access to water, after domestic and agricultural uses. During crisis periods of water shortages, low priorities would cause industries that are dependent on the DWB for their daily water service to lay off employees on days when there would not be enough water to meet their needs. Employee layoffs would lead to lower annual incomes and lower living standards for affected employees, and for personnel providing goods and services to the employees. During 1975 the DWB had 334 industries drawing water from its system; but if commercial customers (19,681) and construction water accounts (847) are included in the industrial category, it can be seen that a total of 20,862 businesses could be affected during a crisis. The DWB does not collect data on the number of persons employed by its customers, but it is known that the median income for wage workers in 1976 was $217.09 per week (Chapter 2), and assuming that wage workers in the future will make at least that much, and assuming also an average of five workers per business, the average weekly loss in the event of a shutdown due to a water crisis would be $22,644,658 in wages (5 X $217.09 X 20,682 = $22,644,657.90). This would not be a severe impact on the Denver area's $7 billion annual total personal income, but for the workers involved, especially those at the lower end of the wage scale whose economic status is marginal, any loss of income is severe.

Conservation-Education

According to the Denver Water Board,

> the Water Department has long advocated residential water conservation (statements made in the 1920s reflect this), the formalization of a concerted water-conservation program began in 1970-1971. A public opinion survey conducted by Mr. Robert Carley at the University of Colorado with Denver Water Department funds indicated, in part, that the public may be receptive to conservation programs" (DWB 1974, p. 231).

The conservation-education program already in progress during this drought year of 1977 would have to be intensified to be a successful alternative to the project. Such a conservation-education program would involve several elements - public awareness, universal metering, building codes, local storage, possible system improvement and possible recycling.

Public Awareness

A first step in conservation-education would be a public awareness program to educate residents as to changes in lifestyles and hardware that a successful conservation program will require.

In the transition period to a complete conservation program, the public awareness program would emphasize voluntary rationing and knowledge of current waste in water use.

Universal Metering

A major step toward a complete conservation program would be universal metering. At present, 54.3 percent of DWB customers are unmetered (DWB 1975). A basic concept in a universal metering program is a schedule of escalating rates for consumption beyond basic needs, especially during water shortage periods. In such a program, basic needs would have to be negotiated.

At first, rate escalation would probably be necessary only during shortage periods. If the population continues to increase as predicted, escalating rates may be mandated during the entire year.

Two advantages of universal metering are that it does not require police patrols to conserve water and it permits the customer to establish her/his own system of priorities of water use. In order not to discourage economic development, business establishments would be largely exempt from the escalating rate schedule. They would not be exempt, however, from building codes requiring water conserving hardware.

Building Codes

Implementation of a complete water conservation program would require building codes directed toward in-house practices that would make the most efficient use of water. The codes would require that all new construction employ the latest water-conserving devices. A DWB study of water consumption in the typical customer's household indicated that 50.3 percent of the water used by the average customer was for toilet flushing (26.7 percent), bathing (17.8 percent) and for cleaning and laundry (5.8 percent (Table 2-7). A program to install the most efficient in-house water conserving devices would make significant reductions in water consumption.

Building codes would also require that replacement of inefficient devices would have to be of the latest design. A long-range program to install water efficient devices in existing non-residential buildings could also require replacement of inefficient hardware in older residential buildings.

Local Storage

A conservation method that does not appear to have been investigated for feasibility is local storage of treated water during high runoff periods, which could be held for use during water shortage periods, particularly for horticultural purposes.

Local storage consists of two types - neighborhood and individual. Neighborhood storage would be of two types - surface and subsurface. Surface storage would consist mostly of various types of tanks distributed throughout residential areas. Tanks of this type are used by many municipalities. Subsurface storage would be a type already used in some parts of the Denver area; these are underground tanks which do not intrude on the skyline. Some are covered with recreational facilities such as tennis courts.

Individual storage can also be of a surface or subsurface type. Subsurface storage can be either underground tanks or sunken swimming pools. Surface storage can be achieved through above-ground tanks or swimming pools. The capacity of tanks and pools would be optional for the homeowner. Swimming pools and residential surface storage would, cumulatively, remove a considerable amount of horticultural acreage from irrigation.

Local storage in various combinations has three advantages - conservation, recreation and emergency fire fighting.

System Improvements

It is not clear from the statistics presented in the DWB environmental statement whether or not the DWB distribution system is an efficient or inefficient conveyance. However, the statement is not optimistic about the prospects for saving much water through system improvements.

Recycling

It is not known how many processes would have to be studied to make treated wastewater safe for drinking. No community provides drinking water produced by an advanced wastewater treatment (AWT) plant in the United States today. The Environmental Protection Agency (EPA) does not endorse recycling at this time but does promote further research. The probabilities of using recycling as a water conservation measure appear to be low for the present.

In summary, the most important elements of an education-conservation program will be public awareness, universal metering, building codes and local storage. System improvements and recycling appear not to be feasible in the immediate future.

Water Resources

As was discussed in Chapter 2, under Future Environment Without the Proposed Action, the annual water demand as population grows within the DWB service area, will increase until it equals the reliable annual raw water supply, 312,300 acre-feet. The presently unused supply of the South Platte and Roberts Tunnel systems after losses was determined to be 79,100 acre-feet. As this water is used, average annual flows in the South Platte River watershed would continue to increase until about 1990. Without additional raw water supplies, average annual flows would not increase after 1990. Projected average annual flows and average monthly flows at a number of locations in the South Platte River watershed were shown in Tables 2-27 and 2-28, respectively. Comparison of the discharge data presented in Table 2-7 and Table 2-28 shows increases in the flow of the North Fork of the South Platte River at Grant during every Month of the year. These increases range from 6 percent in June to 409 percent in February. The increased discharge could increase bank erosion on the lower twenty miles of the North Fork of the South Platte River, where there is no channel stabilization.

Average drawdown of Dillon Reservoir during the period, 1966-1973, was 10.2 feet, reducing the water surface area an average of about 394 acres. With the increased diversions from Dillon Reservoir through the Roberts Tunnel, the annual drawdown would approach an average of 42 feet, and drawdown would be greater during those periods of years with below normal streamflow. Such an average drawdown would reduce the surface water area by about 1,270 acres. Generally, the lowest level would occur during the winter and early spring each year, when the reservoir is drawn down to make room for the anticipated snow-melt runoff.

Average annual flows downstream of Dillon Dam would be reduced by the amount of the increased diversions through Roberts Tunnel. When full use of the annual reliable raw water supply is reached, this reduction would average an estimated 83,300 acre-feet per year.

The resulting 83,300 acre-foot reduction of flow in the Colorado River watershed would remove 11,300 tons of dissolved solids from the basin and increase the salinity concentration of Colorado River water at Cameo, Colorado by about 11 mg/l and at Imperial Dam, Arizona by about 7 mg/l.

Aquatic Resources, Geology, Minerals and Topography, Soils, Terrestrial Resources, Climate and Air Quality, Noise, Visual Resources, Land Use

These environmental elements will remain the same as described in Chapter 2, Future Environment Without the Project.

Cultural Resources

This alternative would prevent the loss of the Keystone Bridge, 2.6 miles of DSP&P modified rail road bed, 1.7 miles of Denver and Rio Grande rockwork, the Strontia Springs site and the Deansbury Station site. In addition, the upper (Deansbury) bridge would not be damaged. There would be no increased water flows along the North Fork and the North Fork Historic District would not be impacted through increased flows.

Chatfield Alternative

Description

As an alternative to the proposed action, a treatment plant and pumping station could be constructed at Chatfield Reservoir, twelve miles downstream from the proposed Strontia Springs Dam. Raw water would be pumped from Chatfield Reservoir and piped about 7,000 feet to a treatment plant located between West Plum Creek and the South Platte River (Figure 1-3). A raw water conduit 108 inches in diameter would link the intake tower to the treatment plant. The intake tower and pump station would be located southeast of the existing Chatfield Dam intake tower (Figure 1-3). The tower would be 120 feet high (to ensure it being above the flood pool level) and would include trash racks. Pumps would be capable of lifting water from the 5,426-foot elevation at the intake to the 5,530-foot elevation at the treatment plant (470 feet). Chatfield Reservoir would have to be drained for about one year to allow for construction of the intake structure, pump station, and intake conduits.

The water treatment plant would be similar to the proposed Foothills plant; however, filtration capacity would have to be substantially greater because of lower water quality. About 200 acres of land would be required for the plant with no buffer. Access would be by existing roads. As opposed to the on-line or base nature of the proposed Foothills plant, the Chatfield facility would be employed as a peaking plant, operated as needed to ensure that demands for water do not exceed base-treatment capabilities at Moffat and Marston.

The Chatfield alternative would require large amounts of electrical energy to accomplish the required pumping. Annual energy consumption would range from about 59,442,000 kilowatt-hours initially at the 125 mgd level to about 217,730,000 kilowatt-hours at the 500 mgd level of plant capacity. These figures include both the pumping that the Foothills plant could eliminate from the existing system. To help put this in perspective, the DWB's total consumption during 1975 was about 48,000,000 kilowatt-hours.

Because congressional approval is needed to make a change in the utilization of Chatfield Reservoir, as well as new design and engineering requirements and environmental statement, the DWB estimates that a plant at the Chatfield site could not be operational until 1986.

Treated water would be pumped from the treatment plant to the Hillcrest Reservoir via an alternative Conduit No. 27 (Map 1-3) and the required portion of Conduit No. 27. The alternate 108-inch conduit would follow Roxborough Park Road south to Titan Road and then turn east to intercept the proposed alignment of Conduit No. 27. The total length of Conduit No. 27 would be about 15.5 miles (5,000 feet less than proposed). The design for an alternate Conduit No. 27 would be the same as for the proposal.

The Chatfield alternative would provide a minimum of 4,000 acre-feet of storage. As much as 24,000 acre-feet of storage capacity could conceivably be utilized without the approval of Congress, but 20,000 acre-feet of this capacity is allocated to 100 years of sedimentation and theoretically would not be available after that period. Use of more than 24,000 acre-feet would require congressional approval.

Analysis

Socio-Economic Conditions

Social and economic impacts would occur both during the three-year construction period and during the life of the project. There would be significant human and social impacts on about 250 families or individuals who would receive average gross incomes of not under $16,000 (Table 2-3). Present trends in water consumption could be continued until about 1988.

Water Resources, Aquatic Resources and Soils

Because the existing treatment plants would function as base plants, most of the raw water for treatment would be diverted at the existing Platte Canyon and Highline Canal intakes. Flows below these points would be increased only during periods of peak demand.

Flows through the Waterton Canyon and into Chatfield Reservoir would probably bring about increased bank erosion, channel scouring, and sedimentation rates, with the result that the 100-year projected life of the reservoir would be somewhat reduced. The full extent of this impact is contingent on the intensity of use of the treatment plant and the commitment requirement for raw water. Since flows of equal magnitude would occur in the canyon to the South Platte intake without the project, the impact there is only one of timing, i.e., impacts related to high flows would occur earlier than without the project. Below the South Platte intake higher flows would occur on the peak demand days, when, without the project, shortages would occur (Table 1-3).

The quality of water in the South Platte River would be degraded in the twelve miles of travel from the proposed Strontia Springs damsite to Chatfield Reservoir. In addition, the present quality of water entering Chatfield Reservoir from Plum Creek is inferior to that from the South Platte. Water stored in Chatfield also will be subject to increased growth of algae. Contamination from recreational use at Chatfield and urban runoff entering the water supply from the intervening drainages would necessitate more complex treatment processes. In particular, activated carbon treatment would be required to treat water stored at Chatfield.

Prohibition of primary contact recreation could make Chatfield more attractive from the health standpoint but will raise objections from the recreation public. No existing Federal or State laws deal with the problem of public use of terminal storage reservoirs, and such use is not uncommon in the eastern United States. However, the Colorado Department of Health, the Denver Department of Health and Hospitals, and the DWB are opposed to recreational use of terminal storage reservoirs.

In the areas disturbed during construction, the sediment yield would be increased 1,175 tons over present sedimentation rates and deposited in Chatfield Reservoir. Considering the volume of water in the South Platte, the increased turbidity and effects on aquatic habitat would not be measurable. Higher flows below the Platte Canyon intake would result in additional scouring action in that section of the river which suffers from excessive amounts of sand (from flushing sediments out of intake structures) and from low flows. Aquatic habitat in the stream below these intakes would be improved as bottom sediments are swept downstream into Chatfield Reservoir.

Geology, Minerals, and Topography

This environmental element will be impacted to an insignificant and unquantifiable degree by this alternative.

Terrestrial Resources

Construction of the Chatfield alternative would result in 65 acres of terrestrial habitat (grassland) being committed to space for permanent structures. About 313 acres would be disturbed for a three-year period; however, reclamation measures would mitigate permanent impacts. Since there would be no construction in the South Platte Canyon, impacts on wildlife would be restricted to plains species, i.e., prairie dogs and antelope. As with the proposed action, the trench for Conduit No. 27 would be excavated through two prairie dog towns and across a corner of the known antelope range.

Climate and Air Quality

In the construction area at 125 mgd and 500 mgd air quality would be degraded by dust and vehicle emissions in amounts too small to measure.

Noise

Noise levels after completion of construction probably would not exceed the level of 50 decibels, adjusted (dBA), which is only slightly higher than ambient noise levels. These impacts cannot be mitigated to any particular extent. However, for purposes of this analysis, they are of relatively minor importance and should have little effect on the overall Chatfield recreation plan.

Visual Resources

As indicated on Table 8-1, the visual impacts of this alternative would be comparable to those of the proposed action for power transmission and telephone lines, the water treatment facility, alternative Conduit No. 27 and increased drawdown of Dillon Reservoir. Due to the construction of the roads on the plains instead of in Waterton Canyon, visual contrast resulting from construction of access roads would be low.

Cultural Resources

Although no known historical features would be affected, archaeological sites and/or possible paleontological values could exist on the areas to be disturbed. At present 20 extant sites have been identified by previous surveys in this area. A total of about 312 acres would be subject to disturbance and loss of archaeological and paleontological values. By law, E. O. 11593, inventory will be required prior to earth disturbance and Section 106 compliance is mandatory before the project can begin.

Recreation Resources

The draining of Chatfield Reservoir during construction of the alternate intake and conduit would result in the loss of 1,150 acres of aquatic habitat and most recreation opportunities associated with that body of water for one year. Estimates are that these losses would impact 1.4 million persons who would otherwise visit the area during that year (Corps of Engineers 1974). In addition, the draining would create about 1,150 acres of unattractive mud flats. These flats would affect aesthetic values and be noticeable to occupants of an estimated 7,150 vehicles using State Highway 75 each day of the construction year, or a total of 2.6 million vehicles. After the refilling of Chatfield Reservoir to its 1975 level, about one year would be required for the reservoir to regain the aquatic productive potential of 1976.

Construction, maintenance, and operation of the treatment plant would conflict, to some extent, with the open space and limited access facets of the recreational plan for the Chatfield project. The proposed plant

site would be located on about 200 acres of land designated as open area and would abut lands designated for overnight use and natural or environmental study (Corps of Engineers 1974, plate 3).

Land Use

Table 8-1 summarizes the development of the Chatfield Dam Alternative. As with both the project proposal and the No Action alternative, major topographic, social and economic factors other than presence or absence of any part of the project would control general land use except for the areas actually occupied by project features.

About 252 acres of land presently being used for grazing and about 60 acres of land being dry farmed would be committed to a municipal water works. This would preclude using these lands for other purposes during the life of the project.

At 125 mgd, 75 acres would be used by installation of Conduit No. 27 and at 500 mgd, an additional 75 acres would be used for the additional conduit.

It is probable that urban growth would continue at its present rate, that is, areal urban development of 73 acres annually within one mile of Conduit No. 27 and the second parallel conduit, and a lineal growth rate of about 0.1 miles annually from north to south.

Upstream Dam Alternative

Description

Another alternative to the proposed action would involve construction of a lower dam farther upstream from the Strontia Springs site. A tunnel 8.5 feet in diameter would convey raw water to the proposed treatment plant site. The treatment plant would operate as a base plant and would have the same design as the proposed plant. The diversion dam, located about 10,500 feet upstream from Stevens Gulch and about 200 feet upstream from the City of Aurora's existing water intake for the Rampart Tunnel, would be a concrete gravity flow dam with the entire section acting as an uncontrolled overflow spillway. At an elevation of 6,030 feet, the dam crest would be 50 feet above the streambed with a crest length of approximately 200 feet.

The intake for the tunnel would be an integral part of the dam structure, located approximately at the 6,030-foot level. It would have a simple gated inlet equipped with a trash rack. Sluice gates would be installed in the center of the dam.

At the crest elevation of 6,030 feet, the reservoir would extend about 2,500 feet upstream from the dam, inundate approximately eight acres of land, and contain 97 acre-feet of water. The reservoir would have little sediment-settling capabilities as water turnover would be rapid. Accumulated sediments would have to be removed each year by dredging to maintain the diversion facility. The reservoir has a trap efficiency of ten percent; it would trap about 7,000 tons of sediment annually.

All vegetation below the 6,030-foot elevation would be chipped, removed, and scattered over disturbed areas above the high-water line of the reservoir. About eight acres of brush with a few scattered Douglas-fir trees would need to be cleared.

Construction of the dam would require about 15,000 cubic yards of concrete and 125 tons of steel. Concrete would probably be hauled in from a staging area at South Platte to a two-acre staging area that would be located in the canyon near the damsite.

The west portal of the tunnel would be located just upstream from the right abutment of the dam, while the east portal would remain in the same location as it is for the proposed project. No other portals would be necessary. Tunnel alignment would follow a nearly straight line between the two portals. Tunnel length would be approximately 26,500 feet. With a pay line of 10.5 feet in diameter to blasted rock and a finished inside diameter of 8.5 feet, the concrete-lined pressure tunnel would have a capacity of about 1,100 cubic feet per second (710 mgd). Construction of the tunnel would proceed simultaneously from both portals. Approximately 38,500 cubic yards of tunnel muck would be taken from each portal. Muck from the west portal, together with about 23,000 cubic yards of material excavated from the dam foundation, would be deposited on DWB property along a sand bar near the confluence of the South Platte and its North Fork. Approximately seven acres would be covered to a depth of about three feet. Site reclamation and runoff preventatives would include providing cutoff trenches to prevent drainage, replacing topsoil and revegetating. Muck removed from the east portal would be deposited at the site selected for the proposed project tunnel.

Operation of the treatment plant would produce about 16,100 pounds of sludge per average day at 125 mgd, 38,600 pounds at 500 mgd per average day. Sludge drying ponds would be cleaned three to four times annually. During the life of the project, about 15 acres in the disposal area would be filled and leveled at 125 mgd, 90 acres at the 500 mgd level.

Winter icing conditions would cause this diversion structure to be operative for only nine months of the year and necessarily change the Foothills Treatment Plant operation strategy.

Primary access to the damsite would be from Sedalia through Nighthawk, approaching the dam from the southwest. Although this route has a steep grade at Nighthawk, a historical site, it would be improved to accommodate construction traffic. About five miles would require substantial improvement and realignment and would affect about 30 acres. From the town of South Platte, which is within the North Fork Historic District, to the dam, the road would be improved to a width of 14 feet with turnouts.

A second access route would be from Kassler through Waterton Canyon. Although this route is shorter, the road would require some improvement in order to upgrade it to a 14-foot road with turnouts. Public access would not be permitted along this route until after the construction period.

A 13.2-kilovolt aerial powerline would be constructed from Platte Canyon intake to provide power required for construction of the dam and west tunnel portal. This permanent power line would provide power needed at the dam for operational purposes.

Construction time and manpower for the alternate tunnel would be about 60 percent greater than that required for the proposed project tunnel. Construction fo the dam would require about one year. The overall construction schedule for the project would not change. Overall this alternative would employ an average of 300 persons for about three years.

The operation of the upstream diversion system and treatment plant would require the use of about eight million kilowatts of electricity annually, which would be purchased from electric power companies in the area. This would represent a long range commitment of energy sources that are being depleted to generate electricity.

Analysis

Socio-Economic Conditions

Social and economic impacts similar to those described for the Chatfield alternative would occur if this alternative were pursued. There would be significant human and social impacts on about 300 families or individuals who would be employed and receive average annual incomes amounting to about $16,050. Trends in water consumption and water shortages would be the same for both alternatives as they both provide treatment capability approximately equal to the proposal.

Water Resources

By 1988 average annual flows in the South Platte River below the upstream dam would be 521 cubic feet per second (cfs) without the project. Below the point of diversion, flows would be reduced to 328 cfs, as 193 cfs (at 125 mgd) would be diverted to the treatment plant. Reduced flows would be

experienced in the six-mile stretch of river between the upstream dam and the existing Platte Canyon and Highline Canal diversions.

Aquatic Resources

Approximately 2,500 feet of productive trout stream in the South Platte River would be converted into a rapid water exchange reservoir with low aquatic productivity. The standing crop of fish would be reduced from about 64 pounds per acre of naturally reproduced rainbow and brown trout to approximately 21 pounds per acre. Spawning gravels would be lost in the 2,500 feet of river that would be inundated.

The reduction in flows from 521 cfs (without the project) to 328 cfs in the six-mile stretch of river between the upstream dam and the Platte Canyon intake would probably result in decreased amounts of aquatic habitat and production. Since cross-sections of the channel are not available, the exact amount of loss in unknown.

Geology, Minerals, and Topography

In the construction area at 125 mgd and 500 mgd no significant impacts would be encountered.

Soils

During the two-year construction period and then once each year thereafter, when sediments are dredged from the reservoir, turbidity in the river below the upstream dam would increase. Suspended sediments would be carried about 200 feet downstream into the pool created by Aurora's diversion dam and intake structures. Although the heavier sediments would drop out, the increased turbidity would be carried downstream. The net impact on Aurora's facility would be increased sedimentation rates during the operational phase. In an estimated 25 years or less, the sediments obtained from dredging would completely fill the borrow pit near Kassler. This would positively affect aesthetic values by returning that pit to the original shape of the land. Use of other, subsequently located pits for that purpose would probably result in similar positive impacts.

During normal operation of the facility, turbidity would be slightly decreased by the limited settling capacity of the eight-acre reservoir. However, it probably would not be measurably different from the present level (8 JTU (Jackson Turbidity Units)).

Terrestrial Resources

Construction of the upstream altenative would result in the permanent loss of 75 acres of terrestrial vegetation to permanent project features such as the dam, reservoir, roads, and treatment plant facilities. Another 389 acres would be disturbed temporarily during construction. However, after a three- to five-year reclamation period the disturbed areas would be

returned to a productive state. During construction and reclamation sediment yield from disturbed areas would result in 1,793 tons of sediment being transported into the river. The resulting increase in turbidity cannot be estimated.

Construction activity at the damsite and the west portal of the tunnel would result in harrassment of Bighorn sheep, which, as a result, would probably abandon the portion of their summer range in the lower part of the canyon between the damsite and South Platte. Since summer range is relatively more plentiful than winter range, extreme stress and increases in disease levels would not be expected. However, the Bighorn sheep herd could possibly be reduced from 60-65 head to 45 head as a result of the increased crowding, stress and possible poaching.

During the construction phase, possible use of the area for feeding by peregrine falcons would be precluded. The eight-acre reservoir may provide a minor amount of feeding area for the peregrine falcon as it would attract waterfowl, shore birds and swallows. Two known golden eagle eyries would be disturbed. Nesting eagles in the area would be forced to use alternate eyries outside the area. Since suitable alternate nesting sites are common in the general area, the impact would be minor.

Other wildlife species, including deer, bear, and mountain lion, would be driven from the canyon bottom between South Platte and Kassler as a result of increased human harrassment. In the eight-acre construction area at the damsite less mobile species probably would be lost as they would not be able to find unoccupied niches.

Climate, Air Quality and Noise

In the construction area at 125 mgd and 500 mgd air quality would be degraded by dust and vehicle emissions in amounts too small to measure. Noise levels as high as 90 dBA would occur intermittently in the construction area. Wildlife probably would avoid areas where noise levels exceeded ambient levels.

Visual Resources

The anticipated visual impacts for the dam and reservoir identified in this alterntive would be less than those identified for the same features in the proposal due to the smaller size of the alternative's features (Chapter 3, Aesthetics). Although the impacts would be reduced, it would not be enough to reduce the visual contrast points shown on Table 3-13.

Since the damsite staging area would be inundated after the dam's completion, no long-term visual impacts would be realized.

Impacts on Dillon Reservoir would be the same as those identified for the proposed action.

The deposition site for tunnel muck and material excavated from the dam foundation would become an unattractive visual intrusion at the confluence of the North Fork of the South Platte and the South Platte Rivers. The short-term visual contrast generated by this would probably exceed the sixteen points maximum established for this area (Table 3-13). 1/

Although rehabilitation of the site would reduce the visual contrast, the cutoff trenches would have a reverse effect and may result in a long-term contrast that is still higher than BLM standards for maximum contrast levels.

Improvement of the road between Sedalia to Nighthawk would probably not produce excessively high visual contrasts as long as the existing alignment would be followed. When the final alignment would not coincide with the original, it would be likely that excessively high visual contrasts would result. Visual contrast of the access road in Waterton Canyon would be the same as described in the proposed action.

Cultural Resources

The Deansbury Bridge would be removed from context, about 1/2 mile of the abandoned narrow gage railroad grade would be inundated by the reservoir and the railroad grade would be blocked by the upstream dam. The integrity of the system would be lost as the result. Unknown archaeological and historical values could be disturbed in the 30 acres required for construction of the road through Nighthawk. There may be adverse impacts on archaeological and paleontological values. Because Nighthawk is a historical site and the area around it will be disturbed, Executive Order 11593 inventory will be required prior to ground disturbance. The road between South Platte townsite and Nighthawk is old DSP&P railbed and while it has been modified for an auto road, care must be taken in widening the site. Further, the upper end of the road improvements at South Platte are in the North Fork Historic District and therefore will require a 106/2b statement of effect.

Recreation Resources

Closing Waterton Canyon to public access during the four-year construction period would result in the loss of about 40,000 high quality visitor-use days. These recreational visits would probably be absorbed along the North Fork and along the South Platte below Deckers. Increased use would result in further degradation of facilities, vandalism, and a recreational experience of lower quality.

1/ This feature's location corresponds to the area analyzed in Table 3-13 for inundation and increased stream flows. The area is located in a visual management class III area, as shown on Map 2-11 and described in Table 3-13.

Land Use

About 588 acres of land presently being used for grazing, open space and recreation would be committed to use for municipal water diversion and treatment facilities. Future land use options on this area would be precluded during the life of the project. However, the lands in the canyon and along the conduits would be available for public recreational use. Other land use impacts would be identical with the proposal.

MINOR ALTERNATIVES

Lower Dam

Description

A lower dam that would serve as an adequate diversion structure could be constructed at the Strontia Springs site. The lower dam would rise to 168 feet above the stream bed with a crest length of 510 feet, and would vary in thickness from 150 feet at its base to 40 feet at its crest. It would create a reservoir with a capacity of 2,400 acre-feet and a surface area of 50 acres that would extend 7,800 feet upstream. The reservoir would have a dead storage pool of 600 acre-feet that would accumulate silt for about 30 years, before dredging would be necessary. Diversion of the river prior to construction of the dam would be the same as described for the proposal, requiring upstream and downstream cofferdams and the same 18-foot diameter diversion tunnel. At least 130,000 cubic yards of rock material would have to be excavated for the dam. Construction material for the dam (222,170 cubic yards of concrete) would be from the same source as that in the proposal. The service spillway of the dam would be located in the center so that only a small amount of excavation of the canyon walls would be needed. During extreme flood conditions water would flow over the entire length of the dam crest. Just downstream of the dam a plunge pool 90 feet wide and 25 feet deep would be excavated across the entire canyon bottom.

The river outlet works, the intake system, tunnels, treatment plant, conduits, roads, staging areas, and power lines would be the same as those described for the proposal. Construction time and the number of employees would be the same as for the proposal.

Analysis

The impacts of the lower dam and reservoir would be basically the same as for the proposed dam and reservoir except that the magnitude of each would generally be smaller.

The water exchange rate in the reservoir behind the lower dam would be once every three days. This higher rate of exchange would result in a reduced capability to settle out suspended solids. Of the 700,000 tons of sediment carried into the reservoir annually, an estimated 36,000 tons would accumulate in the dead pool while the remainder would be carried downstream. The water delivered to the treatment plant would have high levels of suspended solids, which would result in the production of 17,800 pounds of sludge daily by the 125 mgd treatment plant and 113,920 pounds of sludge daily at 500 mgd. Sludge ponds would have to be cleaned quarterly at 125 mgd and twice monthly at 500 mgd. Over the life of the project about twelve acres at 125 mgd and 77 acres at 500 mgd would be filled and leveled in the sludge disposal area.

Water passed downstream through the river outlet works would scour the river bed in the 2.6-mile stretch below the dam and above the South Platte Canyon intake, picking up sediment to reestablish the bedload equilibrium (up to 3,600 tons).

The lower dam would convert 7,800 feet (1.5 miles) of free-flowing river to a 50-acre reservoir. Owing to the high rate of water exchange, the reservoir would not support a plankton base adequate to make it a productive reservoir. The standing crop of trout produced would be reduced from 64 pounds of trout per acre in the river to about 21 pounds per acre in the reservoir. The increased littoral area in the reservoir would approximately compensate for its reduced productivity. The resulting fish populations would not change greatly, but spawning gravels would be lost in the 1.5 miles of river to be flooded.

Clearing the vegetation below the high-water line in the reservoir area would result in the destruction of about two acres in riparian vegetation, about fifteen acres of forested area, and about 33 acres of brushy areas. Sediment yield would be increased from 1,631 tons for the proposal during the construction and reclamation phases to 1,664 tons if this alternative were to be constructed. The impact of the differences would not be measurable in terms of water quality of aquatic habitat. The historic sites that would be lost through inundation are the same as if the Strontia Springs Dam would be built; the Keystone Bridge would also be lost.

<u>Elevator Access to the Dam Crest</u>

Description

Instead of a road from Stevens Gulch to the right abutment, an elevator, installed on the back side of the dam, could be used to move operations and maintenance equipment from the floor of the canyon to the dam crest. Foot access to the dam crest would be through the inspection gallery in the dam.

Analysis

The construction of the elevator access would not have identifiable impacts on the environment. However, it would eliminate the need for about 3,000 feet of new road construction through steep, rocky, mountainous terrain. Massive side hill cuts would be eliminated and the total amount of sediment yield would be reduced by 30 tons during the construction and reclamation period. About four acres of forested habitat (montane forest) that would have been destroyed by the proposed road to the dam crest would not be disturbed. This would eliminate aesthetic damage to the canyon walls and thus reduce visual impacts on recreational values.

Fourteen-Foot Standard Road With Turnouts

Description

Reduction of the width of all proposed 22-foot road widening to a maximum of a 14-foot standard width with turnouts and filling on river side, with minimal cutting into the canyon walls, would be carried out. This would include 16,400 feet of ground surface roadway.

Analysis

The reduction of this roadway to a maximum of 14-foot standard width with turnouts would significantly affect the safety and utility of the road. Traffic of passenger vehicles and construction equipment, i.e. large earthmovers, dump trucks, concrete mixer trucks, and buses, would be on a slow two-way basis utilizing turnouts for passing when necessary. This standard of road would pose sight-distance hazards to drivers and would increase the number of accidents.

Underground Power and Telephone Lines

Description

Power and telephone lines could be buried in or adjacent to roads as they are being constructed or upgraded. From the Platte Canyon intake to Stevens Gulch 2.8 miles of 13.2-kilovolt power and telephone lines would be buried during road improvement. During construction of roads in the treatment plant area 2,000 feet of 1.26-kilovolt power and telephone lines would be buried in the new road.

Analysis

Since the underground power lines would not be visible, the adverse impacts related to aesthetics and recreation on about 3.2 miles of aerial power lines would be eliminated. The potential for electrocution of raptors and inflight collisions with conductors would also be eliminated.

Parallel Bridge to the Keystone Bridge

Description

Instead of removing the historic Keystone Railroad Bridge and building a new vehicular bridge across the South Platte River in the Waterton Canyon as part of the access road construction, a parallel bridge could be built downstream. The Keystone Bridge would then be used for non-vehicular traffic (hikers, bikers, etc.) and as an historic interpretive site, with displays of the historic resources within the Waterton Canyon.

Analysis

The construction of the second bridge slightly downstream of the present railroad bridge would have certain environmental impacts. The second bridge would necessitate the construction of new abutments at the stream edge, and new center supports in the stream itself. These would impact aquatic resources, and yield sediment to an unquantifiable degree. A side hill cut, impacting visual resources to an unquantifiable degree, would be needed to achieve adequate right-of-way for the parallel bridge. This minor alternative would preserve the historic resource and setting to a much higher degree than removal of the bridge would provide.

ALTERNATE NEW SOURCES OF RAW WATER

Introduction

General

The Department of the Interior directed that this redraft of the Foothills Draft Environmental Statement include a discussion of new sources of raw water needed to meet the 500 mgd capacity of the Foothills Treatment Plant. A letter dated November 1, 1976, from Jack Horton, Assistant Secretary of the Department of the Interior, Land and Water Resources, stated:

> It is our intention to discuss those alternatives which can reasonably be expected to enable the Denver Water Board to have waters available for treatment at a Foothills plant with a capacity of 500 mgd. The facilities associated with such alternatives may include storage and collection systems on the West Slope, East slope storage necessary to regulate transmountain diversions and/or waters obtained through acquisition of agricultural water rights.
>
> There will be no attempt to show engineering feasibility or economic justification for any of the water supply alternatives. The discussion of water supply alternatives will be limited to a few (two or three) most reasonable methods of meeting the 500 mgd requirements for the Foothills plant. Reclamation will furnish complete writeups on each . . .

In addition, in the approved Environmental Statement Preparation Plan for the Foothills Project (February 8, 1977) a directive is provided for the method of inclusion of this material. It states:

> . . . the revised DES will identify and assess, in a special section of the Alternatives chapter, the general environmental impacts associated with developing alternative additional sources of raw water supply . . .

This section discusses alternative new sources of raw water supplies, and three possible concepts to provide raw water supplies to the Denver Water Board's (DWB) Denver metropolitan service for municipal and industrial use. In describing these concepts or scenarios, the detail is less than appraisal level, and the discussions on features, operations and corresponding environmental impacts of the three concepts are covered in a general manner.

Although there may be any number of other combinations of existing and potential features which could be utilized to develop the required raw water supplies, the three concepts presented here were determined to be representative of alternative new sources of raw water supplies for treatment by the potential Foothills Project.

These potential concepts and their individual features would require a complete and detailed environmental analysis under NEPA (1969), and the preparation of specific Environmental Statements.

Likewise, during the detailed investigation of potential features, historic and cultural resources would be inventoried by qualified personnel as required by Executive Order (E.O.) 11593. Determinations of eligibility for National Register of Historic Places would be made, and Advisory Council on Historic Preservation afforded an opportunity to review resources in accordance with Regulations of Advisory Council on Historic Preservation - Protection of Properties on the National Register; Procedures for Compliance. Other legislation requiring compliance include: the 1906 Antiquities Act, the 1935 Historic Sites, E.O. and the 1974 Historical and Archaeological Data Preservation Act. In

addition, any proposal for development must comply with all applicable Federal regulations, including:

1. Noise Control Act of 1972 (Public Law 92-574);

2. Federal Water Pollution Control Act (Public Law 84-660) as amended by Public Law 92-500 in 1972;

3. Clean Air Act of 1970 (as amended by Public Law 91-604);

4. Reservoir Salvage Act of 1960 (Public Law 86-523) as amended in 1974;

5. Endangered Species Act of 1973 (Public Law 93-205);

6. Executive Order 11593 (Protection and Enhancement of the Cultural Environment);

7. Uniform Relocation Assitance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646);

8. Fish and Wildlife Coordination Act of 1958.

Criteria for Water Supply Concepts

It was concluded that the water supply concepts would include combinations of the following potential features or actions: enlargement of the existing Gross Reservoir, and expansion of the Williams Fork collection facilities of the DWB's existing transmountain Moffat system; enlargement and use of the Corps of Engineers' existing Chatfield Dam and Reservoir; construction of the potential Two Forks Dam and Reservoir on the South Platte River; development of the potential modified Eagle River collection system; development of additional Blue River collection facilities; acquisition of additional water rights by the DWB in Bear Creek and the South Platte River, and the exchange of treated sewage effluent from Denver for downstream agricultural water. The concepts also utilized existing collection, transmission, and storage facilities.

The concepts were formulated using data compiled on previous investigations, including that of private consulting firms, engineering reports, and environmental assessments on DWB proposed project features, and on Bureau of Reclamation and Corps of Engineers investigations and reports. Primary reference material is listed in the bibliography. No additional detailed studies were made on any potential features.

Each concept described was formulated to provide enough raw water to satisfy the annual raw and treated water demand of the DWB at the time the full Foothills Treatment Plant capacity of 500 mgd is projected

to be required. This amounts to the existing 520 mgd treatment capacity, plus the future additional treatment capacity of 500 mgd, making a total of 1,020 mgd water treatment capacity available to the DWB service area.

The DWB has developed procedures using population projections, historic temperature and precipitation data, and historic water-use patterns to estimate the treated water supply needed to meet maximum hourly, daily, and annual demands and to determine when 1,020 mgd treatment capacity (the system's capacity with Foothills implemented at 500 mgd) would be required. Historically, part of the developed raw water supply has been delivered untreated to DWB raw water contractors. Estimates of the raw water requirement at the time the additional 500 mgd would be needed are 378,400 acre-feet for treatment and 27,200 acre-feet for raw water delivery, totaling an average annual raw water requirement of about 405,700 acre-feet at the treatment plant intakes and raw water delivery points. This 405,700 acre-feet was used as a target for all raw water supply concepts developed in this section.

The raw water supply concepts were formulated to combine existing and potential features, including Strontia Springs Dam, to provide for the collection, transmission, and regulatory storage of the raw water to meet the total treated and raw water requirements.

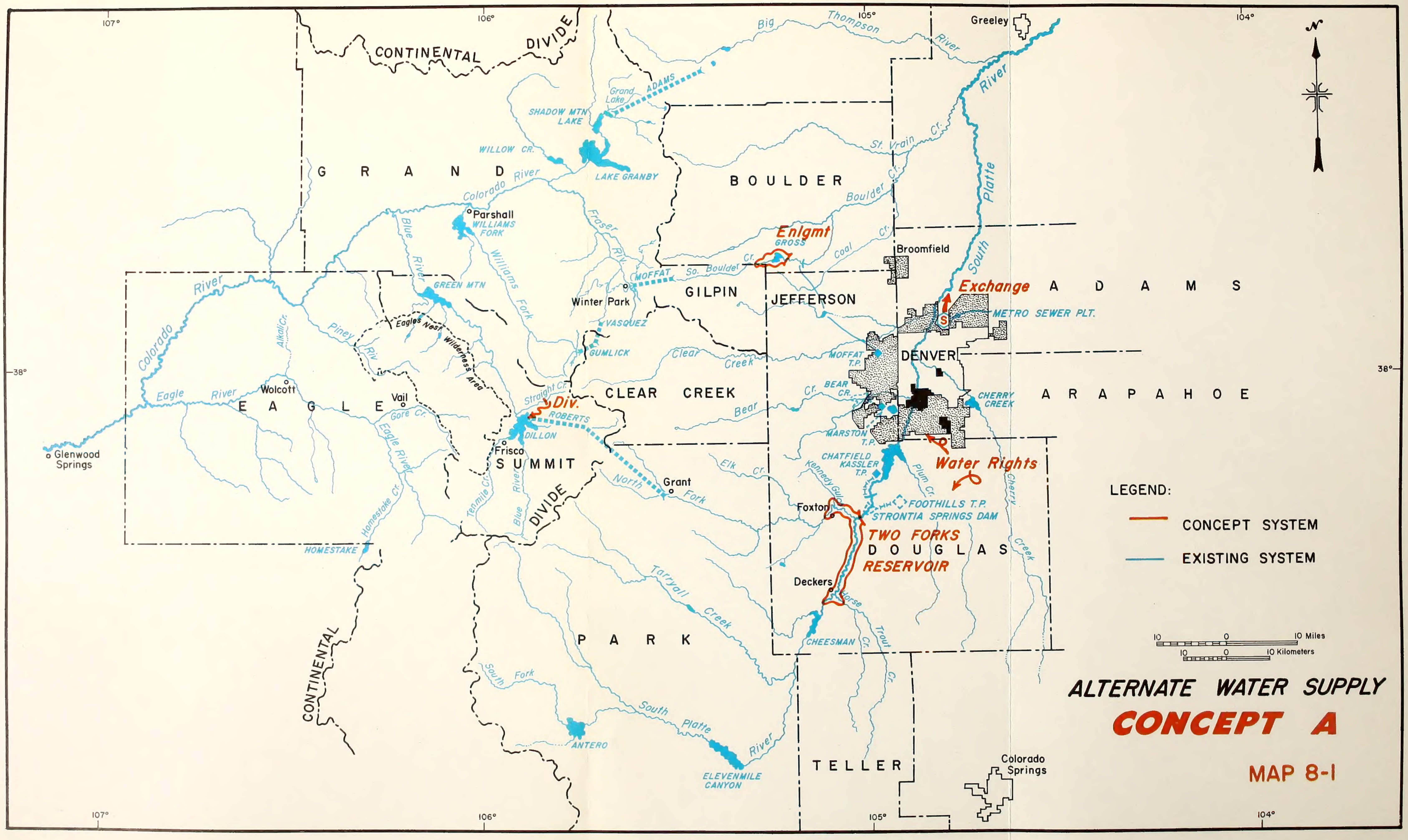
The water supply figures developed for each concept were not determined by actual operation studies, but are considered to be within about 20 percent of the raw water demand. Minimum streamflow requirements, sewage effluent exchange criteria, and supplies derived from water rights acquired but not yet fully defined, may reduce the estimated water supplies in the concepts presented.

Concepts

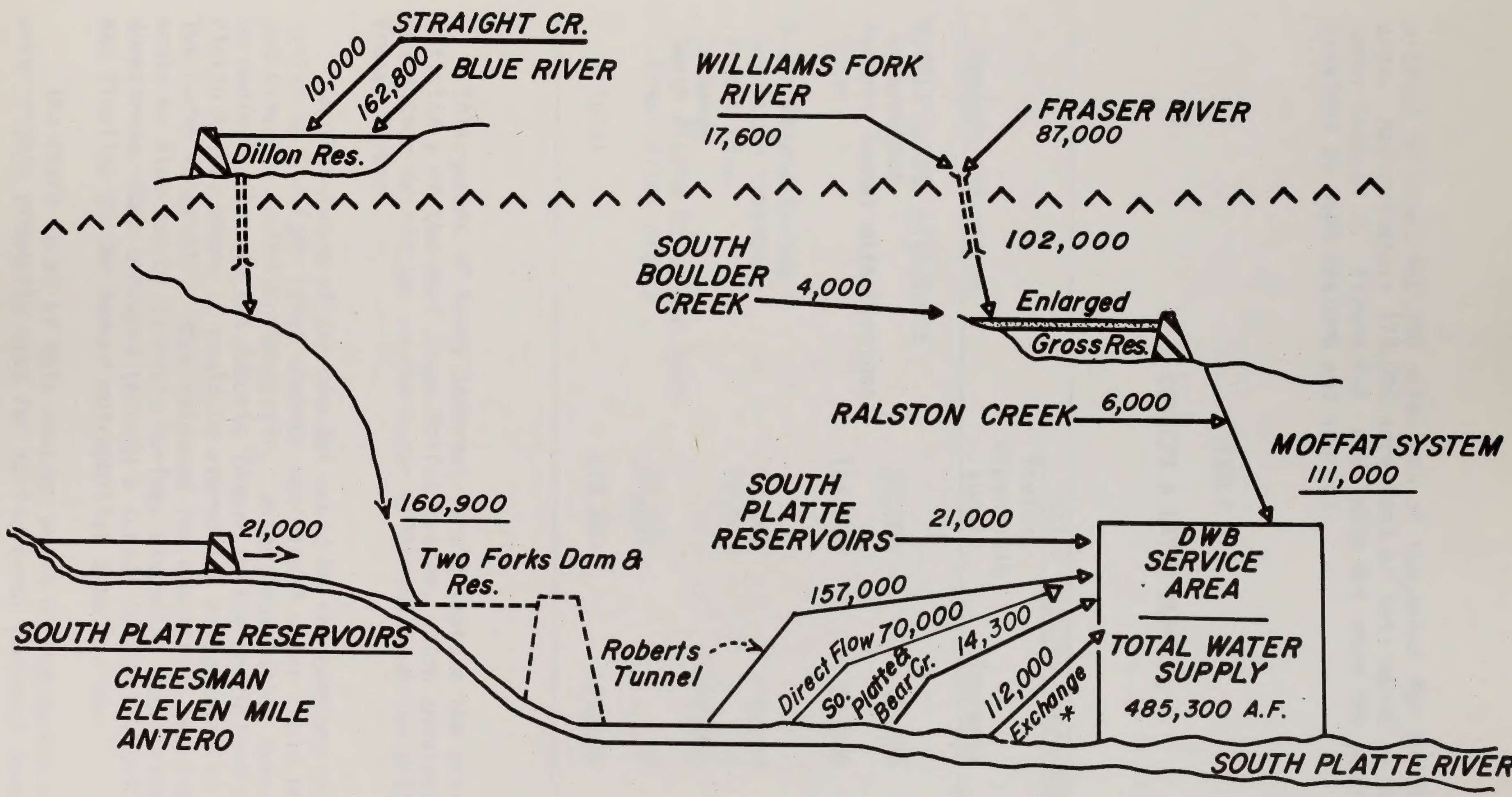
Concept A

General

This concept, shown on Map 1, would permit the DWB to use more water from its west slope Moffat system; expand its west slope Roberts Tunnel system; and provide additional terminal storage facilities, acquire new water rights, and exchange treated Denver sewage effluent for agricultural water within its east slope South Platte River water supply system. From a structural standpoint, the concept would involve enlargement of the existing Gross Reservoir (Moffat), construction of the potential Two Forks Dam and Reservoir on the South Platte River, and construction of new facilities on Straight Creek to divert additional Blue River tributary water into Dillon Reservoir (for the Roberts Tunnel system). The combination of these features and operation modifications would provide



ALTERNATE WATER SUPPLY
CONCEPT A
MAP 8-1



*Exchange includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT A

FIGURE 8-3 Rev. 5/13/77

a total of about 485,300 acre-feet of raw water for the Denver metropolitan area. Approximately 173,000 acre-feet of this would be new water provided under Concept A. Figure 8-3 and Table 8-4 show the amount of water provided by each feature and source.

TABLE 8-4

CONCEPT A WATER SUPPLY

Feature and source	Water Supply acre-feet: Present dependable supply	Increase	Concept A Total
Moffat system with Gross enlargement	92,000	19,000	111,000
Roberts Tunnel with Straight Creek	124,000	33,000	157,000
South Platte System			
Reservoir Storage	12,000	9,000	21,000
Direct Flow	70,000	0	70,000
Exchange	-	112,000	112,000
South Platte River and Bear Creek Ditch rights	14,300	0	14,300
Total	312,300	173,000	485,300

Enlargement of Gross Reservoir would improve the overall operational efficiency of the west slope Moffat system, which consists of water collection facilities on the upper tributaries of the Williams Fork and Fraser Rivers.

Another facet of the concept would be the construction of a collection system on Straight Creek whereby additional water could be collected and diverted to Dillon Reservoir. Water from Dillon Reservoir could then be conveyed through the Roberts Tunnel to the North Fork of the South Platte River, where it would be stored and reregulated in the potential Two Forks Reservoir. When released for downstream requirements, it would be diverted by Strontia Springs Diversion Dam located about 3.5 miles downstream, then conveyed through a tunnel to the Foothills Treatment Plant, and finally, to the Denver metropolitan area for use.

The third facet of this concept would be the purchase by DWB of water rights presently used for agricultural purposes downstream of the

Denver metropolitan area be stored and diverted by DWB in exchange for treated sewage effluent.

Description

Features and Operation

South Platte River System. Two Forks Dam and Reservoir would be located on the South Platte River below its confluence with the North Fork in Jefferson and Douglas Counties, sec. 30, T. 11 S., R. 69 W., about 24 air miles southwest of Denver.

Based on a reconnaissance evaluation, a storage capacity of 305,000 acre-feet would be necessary to regulate 172,800 acre-feet from the Roberts Tunnel system (Straight Creek) and 203,000 acre-feet from the South Platte system. The reservoir would also regulate waters acquired through purchase and through exchange of sewage effluents. In addition, dead storage capacity of about 25,000 acre-feet would be provided. A surcharge pool of about 220,000 acre-feet would be needed to control the inflow design flood. Maximum water surface would be 7,515 acres at an elevation of 6,457 feet.

The Two Forks Dam would be a concrete-arch structure, with a height above streambed of 444 feet. An ungated spillway would be provided with a capacity of 32,400 cfs. The outlet works to release water for municipal and industrial use would have a capacity of about 5,200 cfs. Approximately 10,000 acres of rights-of-way would be required for construction of the dam and reservoir.

As Two Forks Reservoir would provide terminal regulatory storage for DWB on the South Platte, certain restrictions on its use would be necessary to maintain high quality water for municipal and industrial use. In this concept, it was assumed that very limited recreational use of the reservoir would be allowed. Only the minimum of access roads and recreational facilities would be provided. There would be no power-boating or body contact sports, and all camping areas, picnic areas, etc., would be provided with vault-type toilet facilities, for periodic removal. Insecticide and other chemical treatments within the immediate watershed would be prohibited. Strong anti-litter control measures would be enforced. Two Forks Reservoir recreational facilities and lands would be under the control of the Forest Service; day-use by the public could be limited.

Two Forks Reservoir would be operated to regulate the South Platte River and transmountain diversions. On an annual basis, 172,800 acre-feet would be diverted from Dillon Reservoir through the Roberts Tunnel and conveyed by the North Fork of the South Platte River to the Two Forks Reservoir. Maximum water storage in the existing South Platte River reservoir system (Cheesman, Elevenmile Canyon, and Antero) would be

maintained in the highest reservoir whenever possible to increase the yield on a long-term basis. Only the minimum river releases needed below each reservoir to meet senior downstream water rights would be provided. Diversion of flows into the North Fork channel would be coordinated with natural flow conditions to minimize degradation and flooding.

Roberts Tunnel System. The next collection system is located on Straight Creek, a tributary of the Blue River, about 1.5 miles northeast of Dillon. It would consist of a diversion structure approximately six feet high and 60 feet long. The water would be conveyed in a 75-cfs underground conduit four feet in diameter, about two miles long, to Dillon Reservoir. The conduit alignment would follow the old Oro Grande Canal No. 1 and No. 2 at about elevation 9300.

The system would divert Straight Creek waters primarily during spring and would yield approximately 10,000 acre-feet a year.

The average annual streamflow in Straight Creek below the diversion point for about 3.5 miles would be reduced by 14 cfs. The flow above the Straight Creek diversion has averaged about 16 cfs annually.

The flow in the Blue River from Straight Creek to Green Mountain Reservoir would also be reduced by an average of 56 cfs during the diversion period. The average flow in this 22-mile reach of the Blue River would range from 500 cfs near the junction with Straight Creek to 1,000 cfs at Green Mountain Reservoir during the diversion period.

The current operation of Dillon Reservoir would change when terminal storage at Two Forks Reservoir becomes available on the South Platte River. Water releases would be increased through the Roberts Tunnel into the North Fork of the South Platte during the summer, fall, and winter. These increased releases would cause the water level in Dillon Reservoir to decrease by an average of 74 feet. This would reduce the surface area from 3,233 acres to 1,416 acres. Spills from Dillon Reservoir, which normally occur in the early summer, during wet years would be decreased.

Moffat System. Gross Dam and Reservoir was completed in 1954 to store a total capacity of about 43,065 acre-feet. The potential enlargement would raise the height of this structure from 340 feet to 453 feet, and increase the conservation capacity to 113,000 acre-feet.

The surface area of Gross Reservoir at maximum storage capacity is 432.1 acres; the surface area of the enlarged reservoir would be 803.5 acres. The present reservoir has a shoreline of 9.9 miles, while the enlarged reservoir would have 12.1 miles of shoreline and would inundate approximately an additional 3,000 feet of South Boulder Creek, at the

upper end of the reservoir. It is anticipated that the present limited recreational use of the land surrounding the reservoir would be continued. No relocation of roads would be necessary. Construction materials for the enlarged structure are obtainable from nearby borrow areas.

The projected operation of the enlarged Gross Reservoir would be very similar to current operations except that the present maximum water-surface elevation (7,827 feet) would reach a higher elevation (7,400 feet) during the spring and summer. The operation would continue in its current pattern during the winter and fall.

With the enlargement of Gross Reservoir, future diversions from the DWB's west slope Williams Fork-Fraser water collection system would be greatly increased. The annual historical diversions from the Fraser River system of about 48,000 acre-feet would be increased to approximately 87,000 acre-feet. Present Williams Fork system diversions would be increased, from a present average of approximately 5,000 acre-feet to 17,600 acre-feet annually. This increased Williams Fork River collection would also increase the base flow in a 3.5-mile reach of Vasquez Creek, between Vasquez Tunnel and the Fraser River collection facility, by 18 cfs.

The total increased yield from these two collection systems, with Gross Reservoir enlargement, would average about 52,000 acre-feet annually. This would require all collection facilities to be operated continually during the water year.

The average annual flow of the 18.3-mile reach of South Boulder Creek between the east portal of the Moffat Tunnel and Gross Reservoir would increase from 72.5 cfs to 144.5 cfs, 52,000 acre-feet.

With increased diversions by DWB's collection and storage facilities on the Fraser, Williams Fork, and Blue Rivers, more replacement and exchange releases from Williams Fork Reservoir could be made to accommodate downstream senior rights.

Present Environment

Soils and Terrestrial Resources. The soils in the South Platte River System area are generally well-drained and located on moderately to highly sloping relief. The predominant parent materials are igneous, Pike's Peak granite, and metamorphic, gneiss and biotite schist. Soils are mostly light-textured, sand to sandy loam, and frequently gravelly. Rock talus, pieces of cobble-sized granite, often dominate the canyon bottom. Soils of the south-facing slopes tend to be thinner than those on north-facing slopes, which have more vegetation and have undergone less erosion (BR 1973). A more detailed description of soils follows under a separate heading.

The primary vegetative types in the South Platte River System study area (5,600 to 7,800 feet) are: (1) ponderosa pine - shrubland (chaparral) complexes, (2) Douglas fir - ponderosa pine mixed forests, and (3) cottonwood - willow riparian (streamside habitat.

-The Ponderosa Pine - Chaparral Complex. This vegetative community occupies sunny south-facing uplands and canyon slopes throughout the area. Generally, pine trees are quite widely-spaced, and the understory vegetation is extremely abundant and diverse. Blue grama and June grasses provide principal ground cover, while scrub (Gambel's) oak and mountain mahogany are the dominant shrubs. Other plants commonly found in this vegetative community include: (1) (grasses) big and little bluestem, needle-and-thread, mountain muhly, wheatgrass, bluegrass, (2)(shrubs) antelope-brush, big sage, saltbush, wax currant, gooseberry, rabbitbrush, snowberry, three-leafed sumac, yucca, (3) (cactus) prickly pear and mountain ball, and (4)(forbs) locoweed, geranium, cinquefoil, paintbrush, and yarrow.

As this shrub-dominated vegetative type is snowfree most of the year, it serves as critical winter range for mule deer, elk, and Bighorn sheep. Other mammals found in this ecosystem include desert cottontail, Abert's squirrel, black bear, porcupine, mountain lion, bushy-tailed woodrat, coyote, bobcat, and Colorado chipmunk. Representative birds include magpie, scrub jay, rock wren, roufoussided towhee, pygmy nuthatch, mountain chickadee, yellow-bellied sapsucker, red-shafted flicker, and Steller's jay. Rocky cliffs within the shrubland community are a preferred nesting habitat for the prairie falcon and golden eagle. Also, the western rattlesnake, garter snake, tiger salamander, and Woodhouse's toad often occupy this habitat type.

-Douglas Fir-Ponderosa Pine Mixed Forests. Variations of this vegetative type are common in the South Platte Canyon. Since pine saplings are intolerant of shade, stands of Douglas fir predominate on the steep, moister, north-facing slopes. Where slopes are not quite so severe, the crown closure of Douglas fir is not complete and ponderosa pine are more abundant. Open stands of ponderosa pine dominate the drier, more exposed canyon uplands.

Other plants commonly found in the ponderosa pine - Douglas fir association include: (1) (grasses) fescue, brome, (2) (shrubs) common juniper, Rocky Mountain maple, chokecherry, ninebark, gooseberry, kinnikinnik, wild rose, rock spirea, and (3) (forbs) cinquefoil, penstemon, stonecrop, anemone, yarrow, and paintbrush.

The ponderosa pine-dominated forest characteristically has a much more abundant and diverse understory vegetation than either the Douglas fir-dominated stands or ponderosa pine-Douglas fir mixed forest, and thus supports a more diverse wildlife community. Several species of

wildlife, for example, the locally abundant tassel-eared Abert's squirrel, are dependent on the ponderosa pine forest for food and cover. Also, the Merriam's turkey is apparently dependent on ponderosa pine trees for roosting habitat. Other mammals typically occupying the openings of ponderosa pine stands include the coyote, white-tailed jackrabbit, badger, mule deer, northern pocket gopher, meadow vole, and a variety of ground squirrels. The pygmy nuthatch and mountain bluebird prefer to nest in ponderosa pine forests.

Mammals typically found in ponderosa pine - Douglas fir mixed stands are the black bear, mule deer, porcupine, bushy-tailed woodrat, and Colorado chipmunk. Birds characteristic of this ecosystem include the mountain chickadee, broad-tailed hummingbird, Steller's jay, downy woodpecker, and yellow-bellied sapsucker.

-Cottonwood-Willow Riparian Vegetation. In this habitat type, stands of narrow-leaf cottonwood and thickets of peachleaf willow are interspersed liberally by Colorado blue spruce, aspen, and birch. A variety of shrubs (e.g., chokecherry, box elder, wild plum), grasses (needle-and-thread, wheatgrass), forbs (cow parsnip), sedges, and rushes also contribute to the dense bands of vegetation that parallel the streambeds.

Area mammals most dependent on riparian habitat include the beaver, mink, water shrew, cottontail rabbit, raccoon, striped skunk, and mule deer. Birds commonly found along the canyon bottom include the dipper (water ouzel), broad-tailed hummingbird, loggerhead shrike, western flycatcher, warbling vireo, mallard, blue-winged teal, great horned owl, belted kingfisher, yellow warbler, mourning dove, brown thrasher, and Swainson's hawk.

The Woodhouse's toad and leopard frog are amphibians that commonly inhabit the stream bottoms. Also, an abundance of insects, mostly aquatic forms, are usually present.

Generally speaking, the soils in the Robberts Tunnel System may be classified as cold, deep to moderately deep, and well-drained. They range in location from gently sloping to nearly level, (immediately around Dillon Reservoir and its tributaries), to steeply sloping and sheer rock outcrops and slides (in the uplands of the surrounding drainage basin). Parent materials are mostly granite gneiss (Bureau of Reclamation (BR) 1973). A more detailed description of soils follows under a separate heading.

The primary vegetative types within this elevation range, 8,500 to 11,500 feet, are: (1) ponderosa pine Douglas fir mixed forests, (2) lodgepole pine stands, (3) aspen groves, (4) sprucefir forests, (5) upper montane-subalpine dry meadows, (6) upper montane-subalpine wet meadows, and (7) high mountain forest riparian.

The ponderosa pine - Douglas fir mixed forest has been previously described herein for the South Platte River System.

-Lodgepole Pine Stands. In this area, this vegetative type generally occurs above 8,500 feet and results from the disruption of climax vegetative communities, especially by fire. Depending on elevation, they are successional either to Englemann spruce subalpine fir or ponderosa pine Douglas fir forests. Following establishment, dense growths of young lodgepole pine drastically reduce the amount and diversity of understory development. Thus, these stands of "dog-hair" lodgepole generally provide poor wildlife habitat. However, over the years, the stands do begin to age and thin out, allowing seedlings of the appropriate climax vegetation to appear.

Understory vegetation of lodgepole pine forests is dominated either by kinnikinnik (bearberry) or huckleberry (blueberry), depending on elevation. Other plants which may occasionally find living space in lodgepole pine forests include: (1) (trees) limber pine, (2) (forbs) golden banner, lupine, anemone, locoweed, (3) June grass, and (4) club moss.

Generally, only animals which rely on pine seeds as a primary food source prefer lodgepole forests, including the red squirrel (chickaree), Clark's nutcracker, gray jay, Steller's jay, and Colorado chipmunk.

-Aspen Groves. These ecosystems are also a disturbed area, subclimax vegetative type. Within this area, aspen groves have characteristically invaded the coarse soils of exposed ridges. Aspen can readily occur in extremes of elevation and soil moisture conditions. Young stands of aspen are quite dense but still permit sufficient light penetration for development of abundant and diverse understory vegetation. Thus, aspen groves usually support more diverse wildlife communities than do stands of lodgepole pine.

Typical understory vegetation includes: (1) seedlings of Englemann spruce, subalpine fir, lodgepole pine, Rocky Mountain juniper, and Douglas fir, (2) a wide variety of forbs and shrubs (e.g., yarrow, pussytoes, mountain strawberry, blue columbine, sego lilies, dandelion, Oregon grape, elderberry, fringed sage, wild rose, buffalo berry, spreading juniper, chokecherry, and (3) several grasses and sedges.

Aspen are a critical food source for beaver and elk, especially during the winter months. Representative birds include the blue grouse, tree swallow, Williamson's sapsucker, red-shafted flicker, hairy woodpecker, Steller's jay, and gray jay.

-Englemann Spruce - Subalpine Fir Forests. These vegetative communities are the dominant climax vegetative type above 9,500 feet in the concept area. Usually this growth occurs in dense stands with overlapping canopies on steep, rocky slopes. Spruce-fir stands often contain a few, widely scattered lodgepole and aspen. The understory vegetation

forms a continuous groundcover and it dominated by broom huckleberry (mountain blueberry). But, due to the normally heavy snowpack, greater than in any other Rocky Mountain life zone, fire does not pose a serious threat to this ecosystem. Often, snow does not completely recede from the spruce-fir zone until late summer. Other spruce-fir understory vegetation includes: (1) (forbs) arnica, lousewort, tall chiming bells, Jacobs ladder, blue columbine, American bistort, (2) several grasses and sedges, and (3)(shrubs) redberried elder, prickly currant. This habitat type is used by both elk and deer as summer range, and by bighorn sheep, on occasion, during all seasons. Other mammals exhibiting a definite preference for the spruce-fir forests include the snowshoe hare, marten, red-backed vole, vagrant shrew, and red squirrel. Birds which nest in spruce-fir forests include the blue grouse, mountain chickadee, Clark's nutcracker, gray jay, common raven, and goshawk. Also, white-tailed ptarmigan winter in the upper fringes of this ecosystem.

-Subalpine Dry Meadows. In the concept area, these ecosystems occur on level to gently-rolling terrain, between 9,000 and 11,000 feet, and are typically found in close association with scattered lakes and streams. Usually these meadows appear quite shrubby including cinquefoil, willow and aspen saplings, and wild rose. The meadow edges are usually dominated by aspen groves which gradually blend into the surrounding spruce-fir forests.

Common grasses of the dry meadow include tufted hairgrass, alpine timothy, blue joint reedgrass, and bluegrass. Characteristic forbs include antennaria, yarrow, daisies, primrose, larkspur, blue columbine, arrowlead balsamroot, and paintbrush.

-Upper Montane-Subalpine Wet Meadow. This ecosystem is very distinctive from the dry meadow due to its extremely high soil moisture content. It also differs from the streamside riparian ecosystem, primarily because it covers much larger areas and is associated with non-moving or only moderately moving water bodies. Commonly occurring vegetation includes: (1) (shrubs) snow willow, arctic willow, bog birch, (2) (grasses) blue grama, bog bluegrass, reed grass, brome (3) (forbs) elephantella, white marsh-marigold, king's crown, gentian, buttercups, sedum, pussytoes, golden banner, stonecrop, and (4) sedges and rushes.

The subalpine wet meadow habitat type provides high quality food and cover for wildlife throughout the year. Mule deer often depend on the willow bogs for browse. Beaver regularly dam up the streams, helping maintain the water level and perpetuate the ecosystem. Other characteristic mammals include the meadow vole, northern pocket gopher, coyote, and water shrew.

Nesting birds include the mallard and blue-winged teal (near standing water), and the robin, warbling vireo, and song sparrow (dense willow thickets). The abundance of voles and other small mammals make this habitat type an important source of prey for such raptors as the red-tailed hawk.

-High Mountain Forest Riparian. Commonly occurring between 9,000 and 11,500 feet, this vegetative type is characterized by mixed stands of Englemann spruce, subalpine fir, and aspen directly bordering both sides of small tributary streams on moderate to steep slopes. The forest canopy completely encloses the streambed in many locations. Thickets of snow willow, arctic willow, bog birch, and river birch are typically scattered throughout the streambed. Marshy streambanks support a diversity of forbs, grasses, sedges, rushes, mosses, and lichens. Some of the more common water-loving plants are mertensia, elephantella, queen's crown, and marsh marigold.

Wildlife often concentrate along these small mountain stream courses, as they afford good sources of browse and water directly adjacent to dense cover. Beaver depend on streamside willow and aspen for food and dam-building material. Mink and water shrews are both highly dependent on stream ecosystems for food and cover. Mule deer readily browse willow and aspen. Characteristic stream-dwelling birds include the dipper (water ouzel), western flycatcher, warbling vireo, and broad-tailed hummingbird.

In general, soils of the Williams Fork-Fraser River drainage of the Moffat System should be similar to those previously described for the Roberts Tunnel System.

The primary vegetative types found in the Williams Fork-Fraser River area (8,900-11,000 feet) are: (1) lodgepole pine stands, (2) aspen groves, (3) spruce-fir forests, (4) subalpine dry meadows, (5) upper montane-subalpine wet meadows, and (6) high mountain forest riparian. The dominant plant and associated wildlife species characteristically found in each of these ecosystems have been previously described for the Roberts Tunnel System.

Surface deposits in the Gross Reservoir-South Boulder Creek area of the Moffat System are primarily colluvium, slope wash, talus, alluvium, and man-made fill. Colluvium is composed of angular rock fragments that have accumulated by gravity. Some of this colluvial material has been worked and redeposited by water, and is referred to as slopewash; it ranges from silt-size particles to boulders several feet thick. Colluvium and slopewash generally occupy gentler slopes and benches in the bedrock, and are less than five feet thick. Talus is colluvium that has been deposited in cone or fan-shaped forms. Alluvium is sand, gravel, cobbles, and boulders deposited along and in a stream channel. Drill holes indicate that the alluvium in the study area ranges from 12 to 26 feet in depth (DWB 1976). The primary bedrock unit in the Gross Reservoir area is a hard, medium to coarse-grained granite. A more detailed description of soils follows under a separate heading.

The primary vegetative types found in the Gross Reservoir-Boulder Creek area are: (1) ponderosa pine shrubland (chaparral) complexes, (2) Douglas fir - ponderosa pine mixed forests, and (3) cottonwood - willow

riparian (streamside) habitat. The dominant plant and associated wildlife species found in these three ecosystems have been previously described herein for the South Platte River System.

This information was excerpted from the Soil Conservation Service's Range Site Descriptions for the State of Colorado. These soil descriptions apply to general geographic areas (referred to as range sites), climatic conditions, and climax vegetative associations (e.g., wet meadow, subalpine forest), at specific elevations.

In order to avoid redundancy, this information is presented as a single entity in lieu of individual discussions for each of the three systems. However, the nature of soils within each of the three Concept A areas may be acquired from careful analysis of the summary of range site descriptions shown on Table 8-5 and in the brief descriptions of climax zones which follows.

Generally speaking, the soils of the Subalpine Forest Climax are loams to light clay loams, very dark brown or black due to high organic matter, neutral to slightly acidic, and eight or more inches thick. Water storage capacity is moderate to high and, coupled with natural fertility, encourages good production of vegetative biomass.

The soils of the Upper Montane Forext Climax (9,000-10,000 feet) are diverse; all are loams, but they vary in texture and depth.

The Lower Montane-Upper Montane Ecotone may contain all of the range site descriptions within the Upper Montane Climax. The general categories of soil moisture and precipitation are also applicable to this ecotone, with the possible exception of a slightly longer growing season and a lesser percentage of the precipitation occurring as snow.

Lower Montane Forest Climax is found between elevations of 6,000 to 7,500 feet. Many of the range sites described under the Upper Montane Climax and the Lower Montane Climax also occur at the upper level of this climax type (rocky loam, mountain meadow, stony loam, loamy park, mountain loam, and shallow loam). The predominant soils of the lower montane are referred to as foothill types. The foothill soils are generally not as coarse as those of higher elevations and tend to have clayey or sandy textures.

Within the study area, the Grassland-Foothill Climax occurs between 5,000 and 6,000 feet and contains elements of the foothill range sites, plus the sandy meadow soil type discussed in the previous section, Lower Montane Forest. In general, the montane soil types abut or overlap the upper elevations at which the Grasslands-Foothills Vegetative Climax begins.

RANGE SITE CHARACTERISTICS

Range Site	Texture	Depth (inches)	Slope (percent)	Water Holding Capacity	Precip.	Vegetative cover	Other
Subalpine Forest Climax							
Subalpine Loam	loam to clay loam	8+	--	moderate to high	--	Mountain parks-open grassland	very dark color slightly acidic
Wet Meadow	sandy loam to sand and peates and mucks	8+	mostly 0-3	moderate to high	--	meadow	very dark color acidic, poorly drained
Upper Montane Forest Climax							
Rocky Loam	cobbly loam	8	3-25	low	15-20"	forest-25% cover	
Mountain Loam	gravelly loam to loam	8-12	5-40	moderate	--	forest	
Loamy Park	fine sandy loam to loam	12+	3-40	moderate to high	15-20"	open grassland with some trees, 40% cover	dark color 50-100 day frost-free period
Shallow Loam	loam to fine sandy loam	12	2-40	moderate	15-20"	mixed forest and grass	dark color 90-110 day frost-free period
Mountain Meadow	sandy loam to loam	24+	3-40	moderate to high	15-20"	open grassland	dark color 50-100 day frost-free period
Lower Montane Forest Climax							
Loamy Foothill	loam to clay loam	12-24	2-20	moderate	12-16"	--	130-150 day frost-free period
Shaly Foothill	clay loam to sandy clay loam	8-36	2-20	high	15-19"	--	120-150 day frost-free period
Gravelly Foothill	gravelly loam to gravelly sandy clay loam	12-24	5-20	moderate	13-16"	30% optimum	
Cobbly Foothill	cobbly clay loam	12-36	5-20	high	15-18"	--	--
Rocky Foothill	stony loam	24+	5-29	moderate to high	11-16"	--	120 day frost-free period
Shallow Foothill	sandy loam to loam	20	0-35	low to moderate	11-16"	25% optimum	120-150 day frost-free period

TABLE 8-5 (cont.)

RANGE SITE CHARACTERISTICS

Range Site	Texture	Depth (inches)	Slope (percent)	Water Holding Capacity	Precip.	Vegetative cover	Other
Sandy Foothill	loamy sand to sandy clay loam	24+	2-10	moderate	11-16"	35% optimum	120-150 day frost-free period
Sandy Meadow	sandy loam to loamy sand	24+	0-3	low to moderate	13-17"	--	salty, high water table
Grassland Foothills Climax							
Loamy Plains	loam	24+	0-10	high	11-17"	35% optimum	160-170 day frost-free period
Sandy Bottomland	sandy loam to sand	36+	0-10	low to moderate	13-17"	40% optimum	--
Wet Meadow	sandy loam to loamy sand	12-36	0-6	moderate	13-19"	60% +	salty, high water table
Clayey Plains	clay loam to clay	24+	2-30	high	13-17"	40% optimum	slow water intake rate
Salt Flat	clay loam to clay	24+	0-6	high	11-19"	25%	saline, sodic
Salt Meadow	sandy loam to clay loam	12+	0-4	moderate	10-19"	50% +	saline, sodic, high water table
Gravel Breaks	gravelly sandy loam to gravelly sand	6-24	4-20	low	13-17"	30% optimum	--
Overflow	sandy loam to clay loam	36+	0-6	moderate to high	13-19"	50% +	alluvial soils

Aquatic Resources. The South Platte River between Deckers and Waterton is an extremely productive trout stream. A recent three-year sampling indicates that there are approximately 114 pounds per acre of trout in this stream reach (personal communication, Fish and Wildlife Service (FWS) 1977), consisting primarily of rainbow and brown trout (Table 8-6). Rainbow trout population is maintained with stocking program and natural reproduction, while the brown population is sustained through natural reproduction. This river reach is also highly productive of trout food organisms (International Engineering Corporation (IECO), 1973). Dominant aquatic invertebrates are mayfly naiads, with dipteran larvae and flatworms making important contributions to the invertebrate biomass.

The North Fork of the South Platte River is a moderately productive cold-water fishery, consisting primarily of rainbow, brown, and brook trout, although there are reportedly very few brook trout in the lower reach (IECO 1973). The benthic fauna is considerably sparser than that of the mainstem. The benthos is dominated by aquatic insects, i.e., caddisfly and mayfly naiads (IECO 1973).

There are few data on the fish fauna of Cheesman Reservoir, since it is not managed as a sport fishery. Indications are that the reservoir is good in the tributary streams, the reservoir is also stocked on a regular basis. Recent improvements to Tenmile Creek to provide fish habitat should increase natural reproduction. The fishery is rated as being of State and local importance. However, there has been concern over the excessive growth of rooted aquatics in the Blue River arm of the reservoir.

In the Moffat System, Williams Fork River and its tributaries support cold-water fisheries of varying local significance. The mainstem and the South Fork are regularly stocked, while the headwater tributaries are occasionally-to-never stocked. The mainstem supports the most varied fishery. The tributaries support a less varied fishery, in all cases dominated by brook trout in their lower reaches; in the headwaters, cutthroat trout usually dominate. In the majority of streams dominated by brook trout, there is a tendency to overpopulate. Sculpin are also present throughout the basin, but do not contribute to the fishery.

The primary fish food organisms in these streams are aquatic insect larvae. The dominant insects are mayflies, followed by stoneflies (CH_2M Hill 1976). On the whole, the tributaries range from low-to-moderate productivity, while the mainstem is rather highly productive of aquatic insects.

The Fraser River also supports a cold-water fishery. Rainbow trout dominate in the lower reaches, with brook trout rising to dominate in the upper reaches. The benthos is dominated by mayfly and caddisfly naiads in both the river and its tributaries; dipteran larvae inhabit the slower water areas (Colorado Division of Wildlife 1966, in EPA 1976).

Gross Reservoir is the other terminal storage reservoir for the DWB. It is open to shore fishing, but provides a rather poor sport fishery, since it is dominated by sucker.

TABLE 8-6

FISH SPECIES (PERCENT COMPOSITION) - SOUTH PLATTE DRAINAGE

Stream or Reservoir	Rainbow Trout	Brown Trout	Brook Trout	Cutthroat Trout	Suckers	Kokanee Salmon	Yellow Perch	Other
Cheesman Reservoir	5%	3%	-	-	30%	1%	60%	Trace 1/
South Platte River:								
Cheesman to Deckers	35%	60%	-	-	5%	-	-	-
Deckers to Waterton	50%	45%	-	-	5%	-	-	-
Waterton to Bear Creek	95%	5%	-	-	Trace	-	-	-
Bear Creek Downstream	-	-	-	-	40%	-	11%	49% 2/
North Fork 3/	91%	8%	1%	-	-	-	-	-
Gross Reservoir	12%	1%	-	-	87%	-	-	-

Source: CDW, unpublished stream surveys.

1/ Includes walleye, whitefish, northern pike, carp, and mackinaw.

2/ Rough fish primarily, includes carp (25%), chub (19%), bullhead (3%), sunfish (2%), and trace of channel catfish and bass. Also reportedly lake whitefish, mackinaw, and northern pike (IECO, 1973).

3/ IECO (1973) reports presence of longnose suckers, and probably white suckers, long-nosed dace, creek chub, and various other minnows.

TABLE 8-6 (cont.)

FISH SPECIES (PERCENT COMPOSITION) - COLLECTION SYSTEM

Stream or Reservoir	Rainbow Trout	Brown Trout	Brook Trout	Cutthroat Trout	Suckers	Kokanee Salmon
Williams Fork Reservoir	15%	1%	1%	-	3%	80%
Williams Fork River - Site 1	30%	70%	-	-	-	-
Williams Fork River - Site 2	70%	20%	10%	-	-	-
South Fork (Williams Fork)	10%	-	90%	-	-	-
North Fork (Williams Fork)	-	-	100%	-	-	-
Keyser Creek	20%	-	80%	-	-	-
Other Tributaries - Williams Fork	-	-	100%	-	-	-
Dillon Reservoir	60%	20%	5%	-	-	15%
Straight Creek	-	-	60%	40%	-	-
Fraser Reservoir #1	75%	1%	20%	-	4%	-
Fraser River #2	40%	10%	50%	-	-	-

Source: CDW, unpublished stream surveys.

Water quality of the South Platte system has been previously discussed in the description of the environment for the Strontia Springs Diversion Dam and Foothills Water Treatment Plant. The previous discussion is equally applicable to this section.

Water diverted to the South Platte system is stored in Dillon Reservoir. This water is also analyzed by the DWB regularly. These analyses show that the water in Dillon Reservoir is also quite suitable for a municipal water supply and well within standards (DWB 1973, 1974, 1975, and 1976). However, the salinity of water in Dillon is somewhat higher than that of the water from the Williams Fork system or Gross Reservoir; salinity in Dillon Reservoir ranges from 26 to 200 mg/l and averages around 100 mg/l.

Samples collected in the Williams Fork Collection system during the diversion season exhibited concentrations of dissolved solids ranging from 39 to 58 mg/l (CH_2M Hill 1976), with an average of 50 mg/l. This water is diverted to Gross Reservoir. Analysis of samples from Gross Reservoir (DWB 1974, 1975, and 1976) indicate that the salinity is similar to that of the diverted water. These analyses (DWB 1973, 1974, 1975, and 1976) show that the water is well within water quality standards for drinking water.

-Important and Endangered Wildlife Species. Except where otherwise referenced, this descriptive information was excerpted from the article by Jones and Jones (1977) in the Appendix of this Environmental Statement. In the early 1800s, 1.5 to 2.0 million bighorn sheep (Ovis Canadensis) resided on the North American continent; however, due to excessive hunting, disease, competition from livestock, and habitat destruction, only 7,000 to 8,000 sheep remained in Colorado by the early 20th century. Today, Colorado's mountains support about 2,000 Bighorns, which are divided into several scattered, intensively managed and researched herds, concentrated primarily to the east of the Continental Divide. The South Platte Canyon of the South Platte River System supports one of these bighorn herds, presently numbering about 60 to 65 animals (personal communication, Colorado Division of Wildlife (CDW), 1977).

During the years 1954-1966, hunting of the Bighorn sheep was allowed in the South Platte Canyon. In total, 42 animals were taken by 92 licensed hunters. This high hunter success ratio (47 percent) is partially due to the relative accessibility of these sheep and their adaptation to the presence of humans.

With the exception of a few bow licenses, hunting was stopped in 1967. The lack of intensive hunting pressure has increased the herd's tolerance to the presence of man. Due to the large volume of hikers, bicyclists, and fishermen which infiltrate the canyon every weekend, the sheep show little regard for human presence. During a 1977 field trip to the canyon, a group of thirteen sheep (two rams, eight ewes, three yearlings) permitted an investigator a direct-line-of-vision approach to within 20 yards.

Golden eagles (Aquila Crysaetos) are protected from hunting and harassment by Federal law. Golden eagles have historically nested and hunted up and down the South Platte Canyon as well as the North Fork of the South Platte.

They have also been observed in the Williams Fork-Fraser River drainage. Golden eagles have been reported as nesting in every subalpine habitat in Colorado (CDW 1976).

-Other Game Species. The most common big game species in the Concept A study area is the mule deer (Odocoileus hemionus) followed closely by elk (Cervus canadensis). The Williams Fork collection system is located in Grand County which is among the top 10 in elk harvests (CDW 1974). The mule deer harvest in this county approached 2,000 animals (CDW 1974), and this area is considered good to excellent for both winter and summer range for these species. Black bears (Ursus americanus) are also common at the lower and intermediate elevations. Mountain lions (Felis concolor) are also found in the potential Two Forks reservoir area. The population is believed to be low, and decreasing due to human disturbance. One animal was taken in the vicinity of Two Forks during the 1974 hunting season (CDW 1974).

Cottontail rabbits (Sylvilagus floridanus) are the most common game species at the lower elevations, while snowshoe hares (Lepus americanus) dominate altitudes above 8,000 feet.

The most common gamebird species within the Concept A study area is the mourning dove (Zenaida macroura). CDW records for 1974 indicate that more than 55,000 of these birds were harvested. The waterfowl harvest of all species for the same period exceeded 15,000, the majority of which were taken in Boulder County. Other game species of note were: blue grouse (Dendragapus obscurus), sage grouse (Centrocercus urophasianus), sharptailed grouse (Pedioecetes phasianellus), bobwhite quail (Colinus virginianus), scaled quail (Callipepla squamate), band-tailed pigeon (Columba fasciata), ringnecked pheasant (Phasianus colchicus) and a few wild turkeys (Meleagris gallapova). Generally speaking, the grouse species inhabit the higher and middle elevations, while the remaining game species occupy the foothills and grassland plains areas. The above lists are not complete but are representative of the game animals occurring in the area.

Endangered Species. The State of Colorado has classified the river otter (Lutra Canadensis) as an endangered species. During the summer of 1976, the Colorado Division of Wildlife (CDW) introduced three otters, obtained as a gift from Newfoundland, into Cheesman Reservoir on the South Platte River drainage. Although the present status and location of the introduced otters is unknown, the CDW has classified portions of the South Platte River drainage as essential habitat for this species (CDW draft report, 1976).

-Southern Bald Eagle. During the last two years, there have been several sightings of a pair of endangered southern bald eagles near Deckers (personal communication, CDW 1977).

-Peregrine Falcon. The State of Colorado has classified portions of the North Fork of the South Platte River and the main South Platte River as essential habitat for the endangered peregrine falcon (Falco peregrinus). A nesting pair of peregrines have been hunting up and down this stream for several years (personal communication, CDW 1977). The peregrine falcon has

also been reported nesting in the south Boulder Creek area (CDW 1976). The State of Colorado has identified the Gross Reservoir vicinity as essential habitat for this raptor.

-Others. According to the 1976 CDW draft report on endangered species, the Canadian lynx (*Lynx canadensis*) has essential habitat within the South Platte area. Recent communication with CDW personnel indicated that the status of these two species in the South Platte Canyon is unknown.

The Canadian lynx and wolverine also historically occupied habitat in the Williams Fok-Fraser River watershed (CDW 1976). Both species prefer to reside in undisturbed tracts of subalpine forests which are common in this area (Burt and Grossenheider 1976).

According to the CDW draft report, historic ranges for three endangered species, the grizzly bear, (*Ursus horribilis*), gray wolf (*Canis lupus*), and black-footed ferret (*Mustela nigripes*) overlap parts of the Concept A area, but none of these animals have been present in recent years.

There are no known endangered amphibians or reptiles in the Concept A area. The State of Colorado has, to date, not published a listing of endangered reptiles and amphibians.

The Boulder Creek watershed probably provided habitat, historically, for the federally endangered greenback cutthroat trout (*Salmo clarkii stomias*). Presently, a tributary to North Boulder Creek, downstream from Gross Reservoir, contains a population of greenback cutthroat trout (personal communication, CDW 1977) .

No other endangered fish species are known to exist anywhere in the Concept A study area (personal communication, CDW 1977).

The *Federal Register* (50 CFR, Part 17) lists 30 plants as proposed endangered species for the State of Colorado. Since the Concept A study area encompasses such a broad vegetative spectrum, it is probable that one or more of these plant species could be present. However, the Federal Government has not designated any habitat as critical for endangered plants, and the State of Colorado has not published an official endangered plant list.

Socio-Economic Conditions, Recreation, and Cultural Resources. The South Platte River system area is rural in character and depends almost totally on the import of goods and services from surrounding urban centers. Only small areas of land are flat enough for cultivation. Some livestock grazing does occur, but it is not practiced on a large commercial basis. One valid mining claim exists near Deckers. There are no significant export industries. The entire local economy is based on small restaurants, service stations, and groceries, serving residents and the vacationer-recreationist.

The existing visual environment for the South Platte River system would be the same as described in Chapter 2.

Most of the population in the area (about 141 full-time residents) is concentrated in small unincorporated communities, or in scattered residences on both the North and South Forks of the South Platte River. Of the full-time residents, many are retired and over 65 years of age. These older persons are long-time residents of the South Platte Valley, many having lived there for 20 to 50 years.

Since most of the area lies within national forest boundaries and little privately owned land is available, population has remained fairly constant for many years. Some people live in the area because of relatively low housing costs, but most seem to prefer the area because of its rural environment. The permanent residents have a strong sense of community identification within their own communities or settlements.

Small communities or settlements in the area include: Buffalo Creek, Pine, South Platte, Dome Rock, Foxton, Twin Cedars, Nighthawk, Oxyoke, Trumbull, Deckers, Ferndale, and Longview. None of these communities have formal political structures since they are unincorporated.

Residents of the area feel that the long threat of implementing water storage development, along with attendant uncertainties, has retarded development and population growth. They also feel that the area has been ignored by public agencies reluctant to spend money on facilities or improvements that might soon be inundated.

The pollution of the river and littering of the area by irresponsible recreationists, and the noise and constant pall of dust from ever-increasing traffic over unpaved roads, cause grievances, which the residents feel are aggravated by inadequate, uncoordinated management by the agencies involved. The result has been a definite lack of rapport between recreational users, landowners, and pubic agencies.

Law enforcement is provided by both Douglas and Jefferson Counties Sheriff's departments. Buffalo Creek and Pine serve residents in the northern part of the area.

Flooding along the South Platte River has endangered the security of life, health, and safety of residents in the valley.

Recreation opportunities are abundant in the area. Visitors to the South Platte-North Fork area come primarily from the Denver and Colorado Springs metropolitan areas, both of which are within a travel distance of one and a half hours.

Major reservoirs of the upper South Platte River system include Antero (1,000 surface acres), Elevenmile (1,400 surface acres), Cheesman (875 surface acres), and Chatfield Lake (25 surface acres).

Antero Reservoir had 55,000 visitor days in 1971; it is highly productive for rainbow, brown, and brook trout. Elevenmile Reservoir had 182,000 visitor days in 1971; it has natural reproduction of rainbow and brown trout besides regular stocking.

Cheesman Reservoir is closed for public use; however, adjacent land areas and the dam and South Platte River immediately downstream receives several thousand visitors annually. Major activities include auto driving, hiking, motorcycling, cold-water fishing, and big game hunting. The annual recreation use is substantially below the recreation potential of the reservoir. Cheesman Dam, completed in 1905, is on the Historic American Civil Engineering Record.

The South Platte River from Antero Dam to Waterton is a unique and valuable recreation resource. It provides good fishing for rainbow and brown trout because it is heavily stocked. Only 3 to 4 miles of water is open to the public between Cheesman Reservoir and the Wigwam Club.

The river reach from Deckers to the confluence with the North Fork provides a diversity of recreation opportunities, as shown in Table 8-7. There were 221,000 visitor days in 1971, with auto driving accounting for nearly 45 percent of the activity. Picnicking at 7.6 percent and fishing at 7.4 percent were next.

Fifty percent of the recreational use along the above South Platte River reach occurs on Saturday and Sunday, with the remainder spread fairly evenly over the rest of the week. Approximately 75 percent of the use occurs during the peak season, between Memorial Day and Labor Day. Recreation demand far exceeds the facilities provided, and use would probably be much greater if additional facilities were provided. The absence of camping fees and restrictions is an added attraction to the young and low-income groups. One of the major recreational activities that has recently been developed in the area is motorcycling. In spite of efforts of off-road vehicle organizations to police their own activities, the physical environment in the area is being damaged by both motorcycles and four-wheel drive vehicles. Terrain damage, plus the irritating noise to most other recreationists and residents, result in constant complaints. Use of motorized vehicles is prohibited in Waterton Canyon from Kassler to South Platte.

Th only National Register of Historic Places site within the immediate Two Forks impact area is the North Fork Historic District (1974). This historic district extends from the confluence with the South Platte River up the North Fork to Pine. Within the district is the South Platte Hotel, a frame structure in the town of South Platte.

A preserved portion of the Denver South Park and Pacific narrow gage railroad bed is also located along the North Fork from below South Platte to Bailey. The home of Elias M. Ammons, who was Governor of Colorado from 1913 to 1915, is of interest. There are other National Register sites in the Buffalo Creek area, including La Hacienda, Green's Merchantile Store, Green Mountain Ranch, and the Blue Jay Inn. The sites are all under Section 106 portection of the 1966 Act.

Little is known with regard to prehistoric man's activities in the areas of investigation. Information gathered on the upper reaches of the canyons on both the North Fork of the South Platte and the South Platte proper

TABLE 8-7

TYPES OF RECREATIONAL ACTIVITIES -- 1971
TWO FORKS MANAGEMENT COMPOSITE

Activity	Visitor Day Use (Thousands)	Percent Of Total
Auto Driving	99.3	44.9
Scooter-Motorcycle Driving	4.6	2.1
Ice Snow Craft Driving	.7	.3
Foot Hiking Walking	1.2	.5
Horse (Horseback Riding)	.3	.1
Canoe (Canoeing)	5.7	2.6
Other Watercraft (Rowing, Drifting, Rafting)	7.1	3.2
Swimming Bathing	5.5	2.5
Fishing (Cold Water)	16.3	7.4
Camping (General)	12.9	5.8
Camping (Auto)	14.4	6.5
Camping (Trailer)	12.4	5.6
Camping (Tent)	12.7	5.7
Organization Camping (General)	1.2	.5
Picnicking	16.8	7.6
Recreation Residence	5.4	2.4
Snow Play	.2	.1
Hunting (Big Game)	.3	.1
Hunting (Small Game)	.2	.1
Hunting (Waterfowl)	.5	.2
Nature Study	.1	.0
Gathering Forest Products	1.7	.8
Acquiring General Knowledge and Understanding	1.6	.7
COMPOSITE TOTAL	221.1	

Source: Computer Data File, Pike National Forest, Colorado, USFS 1971.

indicates an occupation span from early Archaic (6,000 B.C.) to the present time. The prehistoric materials indicate two major types of sites: occupation sites (mostly open camps), and special function sites. The occupation sites are most numerous where there is a relatively large amount of usable land area that is situated near water, and at the junction of two or more microclimes. The sites seem to exhibit a uniformity in subsistence patterns through time. Although specific artifacts do change, their ultimate function does not.

Recent investigations (Windmiller 1974, Windmiller 1975a, Windmiller 1975b, and Emrick 1976) found some 70 prehistoric sites within the Two Forks area. Of these 48 have an unknown time period; 13 are of the Woodland time period; and 9 are of the Archaic time period.

DWB's Roberts Tunnel System centers around Dillon Dam and Reservoir and the west slope conservation and regulation of Blue River water flows provided by this facility. Almost all of the contributing area is within Summit County and the Arapahoe National Forest in central Colorado.

With completion of Dillon Dam in 1964, the new relocated town of Dillon quickly grew and changed the economic profile of the county from one of agriculture and mining to one based almost entirely on tourism.

Today, Summit County, including Dillon and the nearby communities of Frisco, Keystone, Silverthorne, and Breckenridge, provide a mountain-rural setting with a combined population estimated at 6,500 (1977). This represents almost a three-fold increase in population growth since 1970. The general character of the population is one of youth and mobility. Many of the residents in the Dillon-Keystone and Breckenridge area live in mountain condominiums and cabins, many of which are second homes.

Summer tourism in Summit County is mainly centered around Dillon Reservoir and the major ski communities of Keystone, Breckenridge, and Copper Mountain. Dillon Reservoir has a surface area of 3,200 acres, and provides popular public fishing and boating. Forest camping and picnic grounds and hiking trails are located around the reservoir. Dillon received 68,090 fisherman days (a twelve-hour day when fishing is the only activity participated in by any number of fishermen) on water, and 2,000 fisherman days on ice, in 1973. No specific activity statistics are available for the other water activities and related land recreation. However, an estimated 358,000 visitor-days of use occurred in the area during 1973 (Bureau of Land Management (BLM) 1976).

The Blue River and its many high mountain tributary streams and alpine lakes are noted for quality trout fishing. Other summer outdoor activities include unique hiking and camping opportunities in major national wilderness and primitive areas located in the Gore Mountain range. The Gore Range-Eagles Nest area became a designated wilderness in the wilderness system on July 12, 1976.

Green Mountain Reservoir (2,125 surface acres) located on the Blue River about 20 miles downstream from Dillon is considered a major recreation resource. The State Park at the reservoir received 96,199 visitor days and served 4,182 boats in 1975.

Winter sports are centered around five major ski resorts - Loveland Basin, Arapahoe Basin, Keystone, Copper Mountain, and Breckenridge. Because of their close proximity to Denver, these resorts attract hundreds of thousands of people each year from across the nation.

At present, the only site that appears to qualify for the National Register is the Oro Grande Canal No. 1 and No. 2 right-of-way. Present information does not provide the age or condition of this structure. Other historic sites would be related to mining, settlement, ranching, and lumbering activities. There are no known prehistoric resources within the Roberts Tunnel system study area. Expected prehistoric resources would be similar to the Upper South Platte system due to the similarity of the terrain and vegetation.

The Moffat System lies in a scenic environment typical of the Front Range of the Rocky Mountains. The topography consists of granitic foothills with a mixed forest cover of ponderosa, pine, and Douglas fir. Housing developments and road systems are common in the area. The scenery is typical of the Colorado Mountains (Class B). Due to the number of mountain homes in the area, the visual sensitivity is high.

Gross Dam and Reservoir is located in Boulder County approximately 5 miles southwest of Boulder and 35 miles northwest of Denver.

About ten percent of the ten miles of reservoir shoreline is open for public fishing. Fishing is generally poor because of a high non-game fish population.

Nearby forest lands provide limited picnic opportunities. For safety and security reasons, no other recreation use has been permitted on the reservoir or surrounding land areas. Access to Gross Reservoir can be gained from Coal Creek Canyon road (State Highway 72) via a dirt county road.

DWB caretakers and their families are the only residents in the immediate area. No agricultural, business, or industrial uses exist in the area.

The social and economic climate of the area around the town of Fraser in Grand County is primarily based on agriculture and tourism. Located between the ski slopes of Berthoud Pass and Winter Park and the water-based recreational facilities of the Colorado-Big Thompson Project near Granby and the Rocky Mountain National Park, the area is visited by skiers, boaters, fishermen, hikers, and others seeking the advantages of these recreational areas. Broad meadows are here, in which cattle graze, and crops adaptable to the climate are raised. The Fraser Experimental Forest

is located directly to the west of the town of Fraser; it contributed to knowledge and research in the forestry industry.

Camping areas are situated south and west of Fraser, and lodging for tourists and recreationists is available in and near the town.

Permanent residents still intermingle with the transients, stabilizing the community, but gradually deferring to the younger generations. An indication of the economic and social climate of the area is the population increase in Grand County, from 4,100 in the 1970 census to an estimated 7,000 at present.

The Williams Fork and Fraser Rivers and their respective tributaries provide fair to good cold-water fishing opportunities. Williams Fork has many good holes and riffles and is considered one of the better fly-producing streams for rainbow and brook trout (Kelly 1975). Recreation activities in the Williams Fork drainage primarily include fishing, camping (four campgrounds with 6,100 visitor days), hiking, hunting, horseback riding, and snowmobiling (CH2M Hill 1976). The big game hunting is primarily for mule deer (842 hunters with 23 percent success in 1973), elk (1,205 hunters with 18 percent success, 1973), and bear.

There are several historic resources in the Gross Reservoir area including the Denver and Salt Lake Railroad bed and the South Boulder Creek flume. Historic resources in the Williams Fork-Fraser River collection areas are limited to small, isolated multiple structures, associated with railroading, mining, logging, and ranching. There is one historic site on the National Register within the area: Rollins Pass.

Although there are no known archeological sites in the Gross Reservoir area, it is expected that such resources would be similar to those in the Upper South Platte system. Very little prehistoric data has been derived from surveys (CH2M Hill 1976) associated with the Williams Fork collection area. The two chipping stations and a number of isolated finds remain without temporal placement. It is likely that further survey and construction operations will encounter additional materials.

Analysis

Environmental Impacts

General. Construction of Concept A features would result in temporary, localized deterioration of air, noise, and water quality. Noise levels would be increased during construction periods, disturbing wildlife and nearby residents. Soil erosion would increase turbidity in surface water flowing from the construction areas. Increases in dust, hydrocarbons, nitrogen oxide,

and carbon monoxide would result from the operation of construction machinery.

Topsoil and underlying soil and geologic formations would be disrupted during construction. Following construction, trenches and borrow areas would be backfilled and shaped to blend with the natural surroundings.

During construction, strict controls for the protection of wildlife and their habitat could be implemented. However, some terrestrial wildlife would be displaced and lost during construction due to elimination of vegetation within the construction rights-of-way.

Future implementation studies for any of the potential concept features that would be viewed as a significant Federal action would require compliance with NEPA regulations. An environmental assessment of the impacts of the proposed action would be made. This would be the basis for determining whether an environmental statement or a negative determination should be processed. If an environmental statement is required, it would be prepared in compliance with Section 102(2)(C) of Public Law 91-190, the National Environmental Policy Act (NEPA) of 1969.

Terrestrial Resources. The proposed Two Forks Reservoir in the South Platte River System would have a total water surface of 7,515 acres at the maximum water surface elevation of 6,457 feet. The reservoir would inundate and eliminate ponderosa pine - chaparral and Douglas fir - ponderosa pine vegetative types on the South Platte Canyon slopes from just above the streambed to the high water elevation (BR 1973). In addition, the cottonwood willow vegetative complex along nineteen miles of the South Platte River, seven miles of the North Fork of the South Platte River, and nine miles of miscellaneous streams and gulches would be eliminated. The terrestrial plant and wildlife species most commonly found in these three vegetative associations have been previously described.

All trees within the reservoir area, up to elevation 6,400, would be mechanically removed and processed prior to inundation. The alternate flooding and drying of reservoir shoreline, resulting from operation fluctuations of the water surface, would restrict the growth of terrestrial vegetation. This could result in a zone of denuded vegetation, of varying width, encircling the reservoir during most of the year.

Wildlife populations would be displaced by the inundation of the Two Forks Reservoir area. The degree of impact would vary depending on the species involved. Birds, mammals, amphibians, reptiles, and insects dependent on streamside riparian habitat (e.g., beaver, dipper) would be most impacted. Displaced animals would be forced to relocate in adjacent similar habitat. Relocation success for each species will vary, according to the availability of adjacent partially occupied habitat for that species (i.e., habitat which has not reached carrying capacity). Displaced animals

which cannot find habitat within a reasonable migration distance of the project area could perish. Due to the extent of the inundation area, construction of Two Forks Reservoir would result in some loss of wildlife.

Average annual streamflows along a 6.5-mile reach of the South Platte River from the proposed Strontia Springs Dam to Chatfield Lake would be reduced by approximately 90 percent, from the Two Forks Reservoir storage and diversions to the proposed Foothills Treatment Plant. This could result in prolonged periods of streamflows as low as ten cfs through this reach of the South Platte Canyon. Tennant (1975) reports that, for a variety of streams studied, 10 percent of the average annual flow covered 60 percent of the stream substrate, provided 1 foot of average depth, and allowed flows averaging 3/4 cfs in velocity. From this study, he concluded that ten percent of the average annual flow is, at best, a short-term survival flow and that over the long-term ten percent flows would severely diminish the abundance and diversity of riparian vegetation. Such reduction in the quality of riparian habitat would also result in the displacement of terrestrial wildlife species.

Flows in a 37-mile reach of the North Fork of the South Platte would be increased by additional diversions from the west slope collection system. Releases from Roberts Tunnel could be coordinated to approximate the natural flow regime. While flows in the North Fork would be greater than those presently occurring, no additional stabilization would be required. By occupying more of the existing stream channel, these increased streamflows could result in the improvement of the quality of riparian habitat and associated terrestrial wildlife populations.

Construction of the Straight Creek diversion structure to feed the Roberts Tunnel System would eliminate approximately two acres of forest riparian habitat, as previously described. This could result in the displacement of some terrestrial wildlife. In addition, construction of the underground conveyance conduit from Straight Creek to Dillon Reservoir would disturb twelve acres of primarily spruce-fir forest interspersed with some subalpine dry and wet meadow habitat. This could also result in the temporary displacement of some terrestrial wildlife. Following construction of the conduit, the disturbed landscape could be recontoured and revegetated to as near natural conditions as possible.

As a result of the proposed diversion, streamflows would be depleted as approximately 90 percent (i.e., 16 cfs to 2 cfs) along a 3.5 reach of Straight Creek. Tennant (1975) has described a 90 percent reduction in annual streamflow as being destructive to riparian vegetation; thus, the diversity and abundance of the vegetative community along Straight Creek from the diversion structure to the Blue River would be diminished. This could result in some change in the nature of the associated riparian wildlife community. However, due to the extensive development (e.g., interstate highway, condominiums) which has already taken place along much of this stream segment, the degree of impact to remaining terrestrial ecosystems resulting from the potential action should be minimal.

Streamflows in a 22-mile stretch of the Blue River between Straight Creek and Green Mountain Reservoir would be reduced by 56 cfs during spring diversion periods. Given the present average spring flows of between 500 and 1,000 cfs for this river reach, the proposed flow reduction should have no impact on riparian vegetation and associated wildlife populations.

The increased streamflow diversions in the Williams Fork-Fraser River collection area of the Moffat System would reduce average annual flows by 90 percent on 37.3 miles of 13 tributary streams to the Fraser River. Elimination of much of the riparian vegetation, primarily subalpine wet meadow and high mountain forest riparian types, could be expected from such reductions in streamflow. Tennant (1975) reports that over the long-term ten percent flows would severely diminish the quality of riparian vegetation.

Severe reduction in the abundance and diversity of riparian vegetation would result in the displacement of wildlife. Birds, mammals, reptiles, amphibians, and insects which are dependent on this riparian habitat for food and cover would be forced to relocate in adjacent partially occupied riparian habitat. Animals which are unable to find replacement habitat could perish. Due to the number (thirteen) and relative proximity of streams affected by the proposed depletion increases, some displaced wildlife would have difficult relocating.

Proposed depletions would reduce the average annual flows of 2.5 miles of streams in the Williams Fork Basin an additional 30 percent. Increased depletions on these tributary streams could impact the riparian vegetative community and associated wildlife populations. The average annual flow of an 18.3-mile reach of South Boulder Creek between the east portal of the Moffat Tunnel and Gross Reservoir would double (72.5 cfs to 144.5 cfs). This increased streamflow could impact the abundance and diversity of the existing riparian vegetation. Similarly, the projected increase (18 cfs) in base flow on a 3.5-mile reach of Vasquez Creek, between Vasquez Tunnel and the Fraser River collection facility, could impact the associated riparian habitat. The nature of these impacts would depend on such factors as the morphology of the streambed, composition of the riparian vegetative community, and streambank water storage capacity.

The present surface area of Gross Reservoir at maximum storage capacity (43,064 acre-feet) is 432.1 acres, with a shoreline of 9.9 miles. The surface area of the enlarged reservoir (113,000 acre-feet) would be 803.5 acres with 12.1 miles of shoreline. The proposed enlargement would also inundate 3,000 feet of South Boulder Creek upstream from the existing reservoir. At maximum storage capacity, the Gross Reservoir enlargement would inundate 371.4 surface acres of vegetation, primarily ponderosa pine - Douglas fir mixed forests on north-facing slopes, and the ponderosa pine - chaparral association on south-facing slopes (DWB 1976). The plant and wildlife species most commonly found in these two vegetative types have been previously described. Inundation would eliminate the terrestrial vegetation from this acreage and also result in the

displacement of terrestrial wildlife. As previously discussed, if adjacent, partially occupied habitat is available the displaced wildlife should be able to successfully relocate. However, if the adjacent habitat is already occupied to carrying-capacity for individual wildlife species, some of the displaced animals could perish. The abundance of similar habitat in the vicinity of Gross Reservoir should minimize the number of animals that would be unable to successfully relocate.

The habitat lost as a result of the inundation of South Boulder Creek would be primarily the cottonwood-willow riparian complex, (DWB 1976). Terrestrial vegetation would be eliminated in the area of inundation, and associated wildlife would be displaced with the possible loss of some animals.

Aquatic Resources. Construction and operation of Two Forks Reservoir in the South Platte River System would inundate up to nineteen miles of highly productive stream fishery on the mainstem of the south Platte River, and seven miles of a moderately productive fishery on the North Fork. This would be replaced by a reservoir fishery of variable surface acreage, usually between 2,050 and 3,200 acres. Productivity in the reservoir would be low, and probably similar to that of Cheesman Reservoir. Cheesman Reservoir would be opened to fishing and provide an additional fishery of unknown quality and low productivity.

Additional East Slope storage would allow for releases from Roberts Tunnel to a 37-mile reach of the North Fork that would approximate natural flow regimes, although flows would be greater than currently occur. There would be no need for additional channelization. This would result in favorable impacts accruing to the North Fork fishery, due to increased habitat. However, productivity per unit area or for individual fish would remain essentially the same as that of pre-project conditions, because of the continued releases of cold waters from Roberts Tunnel.

The sewage effluent exchange procedure would reduce the flows in the 6.5-mile river reach between the Strontia Springs Diversion Dam and Chatfield Lake to a minimum of ten cfs for prolonged periods. This would essentially eliminate the fishery in Waterton Canyon.

The average flow of 3.5 miles of Straight Creek in the Roberts Tunnel System would be reduced by 14 cfs, or approximately 88 percent, annually. Wesche (1973) found that such reductions in similar streams in Wyoming resulted in a 90 percent reduction in spawning habitat and an 80 percent reduction in food producing area. Similar impacts could be expected in Straight Creek, resulting in significant adverse impacts on the fishery.

The average fluctuation in Dillon Reservoir would increase to about 74 feet under this concept. The maximum drawdown would occur during late winter or early spring, when ice cover is still present on the reservoir.

However, the remaining pool should be large enough to retain an oxygen reservoir sufficient to maintain fish over the winter. The pool would still be over 100 feet deep on the average prior to spring filling.

The enlargement of Gross Reservoir on South Boulder Creek in the Moffat System would provide additional water surface for fish and other aquatic life during the spring and summer. The inundation of additional land would provide for increased productivity in the reservoir from the addition of nutrients from the soils. However, the quality of the fishery would be unlikely to improve unless remedial measures were taken to reduce the proportion of non-game fish.

The increased diversion from the Fraser River system at 89 percent of present flows would leave approximately six cfs immediately below the diversion point. The present aquatic community would be eliminated for a distance downstream to the point where flows would increase enough to support an aquatic community. Under ultimate development conditions, approximately 55 miles of streams in the Fraser River Basin would be depleted to essentially zero flow conditions, thereby eliminating the aquatic community. Downstream from the depleted stream reaches, reduced flow conditions would result in a reduction in productivity and biomass. This latter impact would vary from stream to stream due to varying amounts of downstream tributary inflow and from year to year due to varying amounts of local in-basin runoff from precipitation. This would result in a total reduction of flow of 39,000 acre-feet annually, or an average of 54 cfs on the 19-mile reach of the Fraser River between Vasquez Creek and its confluence with the Colorado River.

An additional 3.5 miles of tributaries of the Williams Fork River would be similarly subjected to depleted flows with a consequent reduction in the productivity of fish and their food organisms. The Williams Fork River in the 5-mile reach to tis confluence with the South Fork would be subjected to an average flow reduction of 18 cfs, or about 30 percent. Sufficient flow (42 cfs) would remain to maintain the same aquatic habitat.

Increased diversions from the tributaries of the upper Colorado River drainage would provide additional high quality water to the Denver metropolitan water system. This would also remove 205,000 acre-feet of diluting water from the Colorado River and would divert an average total of 24,365 tons of salt per year from the Colorado River Basin to the east slope. If these totals are hypothetically superimposed on present modified conditions, as presented in a Bureau of Reclamation report (1976), a salinity increase of 30 mg/l could be expected at Cameo, Colorado, and an increase of about 18 mg/l could be expected at Imperial Dam, Arizona. However, projected future conditions (BR 1976), include a provision for future diversions up to 235,000 acre-feet per year for municipal and industrial use in the Denver metropolitan and Colorado Springs areas. These are assumed to be developable under the terms of the Colorado River Basin Compact and are thus provided for under the terms of the Colorado River Salinity Control Act.

The additional diverted water would be stored in the potential Two Forks and enlarged Gross Reservoirs. Water of similar quality is currently being diverted to the North Fork of the South Platte River and to Gross Reservoir. No impacts on water quality due to additional diversions would result in the South Platte River and Gross Reservoir.

The use of additional water in the Denver metropolitan area would create additional sewage effluent. Due to the provisions for effluent exchange that would be implemented under Concept A, much of this effluent would be used as agricultural water. The impacts on the South Platte River downstream from the metropolitan area cannot be determined until the water use is better defined.

Important and Endangered Wildlife Species. The Colorado Division of Wildlife estimates that up to 50 percent of the carry-over Bighorn sheep herd in the Waterton Canyon could be lost as a result of construction of Two Forks Reservoir (personal communication, CDW 1977). This loss would result primarily from construction activities within the South Platte Canyon while the dam is being built (personal communication, CDW 1977). Increased noise levels from blasting and heavy equipment traffic over a prolonged construction period (three to four years) could change migratory patterns, resulting in some displacement and eventual mortality of sheep. In addition, individual sheep mortality from illegal poaching is probable, due to increased and continuing presence of humans in the area during the construction period.

The impact of project construction on the size of the Bighorn sheep herd would depend on the impacts of construction of Strontia Springs Dam and the time interval between construction of Strontia Springs and construction of Two Forks Dam. If this interval is short (i.e., two to three years), and reduction of herd size from Strontia Springs construction is great (i.e., more than 50 percent), the viability of the Bighorn population in Waterton Canyon could be threatened. On the other hand, if the interval is great (i.e., more than five years) and the carry-over herd is treated for lungworm, a viable population of Bighorns should be maintained in Waterton Canyon.

Inundation of the South Platte study area by Two Forks Reservoir would impact the federally protected golden eagle, and possibly the northern bald eagle. The value of the South Platte Canyon to eagle populations would be temporarily reduced, due to the loss of streamside riparian nesting and perching habitat and associated aquatic and terrestrial prey populations.

Elimination of riparian habitat resulting from increased streamflow depletions in the Fraser River drainage and the enlargement of Gross Reservoir could impact populations of both golden and northern bald eagles. Both species, particularly the northern bald eagle, use riparian habitat for perching, hunting, and nesting. The loss of riparian timber and decrease in

terrestrial prey populations resulting from the proposed development could reduce the value of the Moffat System study area for eagle populations.

Other Game Species. Due to the potential Gross Reservoir expansion, at least 371 acres of terrestrial vegetation would be inundated, and some game animals would be displaced.

Two Forks Reservoir, however, would have a major impact upon game birds and mammals of the South Platte and North Fork ecosystems. State big game harvest records for 1974 indicate that 9 black bear, 50 elk, and about 550 deer were taken in the Two Forks vicinity (Jefferson and Douglas Counties). The loss of habitat should cause a population reduction for each of these species. The small mountain lion population of the South Platte area should be reduced by a loss of habitat and reduction of prey species in the area.

Upland game bird populations in the vicinity should be reduced or individuals displaced, as a result of habitat loss and construction activities. Conversely, waterfowl populations should increase in both density and diversity after the reservoir filling begins.

A potential exists for an impact upon migratory waterfowl resulting in that some streamflows may be depleted during the migratory periods; however, the creation of Two Forks Reservoir and the stabilization of other streamflows should compensate for the total waterfowl loss resulting from flow reductions.

Endangered Species. The only river otters known to exist in the Concept A study area are the three that were introduced into Cheesman Reservoir by the CDW during the summer of 1976. The construction of Two Forks Reservoir would result in the opening of Cheesman Reservoir for public use. This action could impact State-designated essential habitat for the river otter, possibly jeopardizing the CDW introduction program in the South Platte River Basin.

The potential action could impact the nesting and hunting behavior of the pair of southern bald eagles which have been sighted near Deckers.

The federally endangered peregrine falcon could be impacted by the increased streamflow depletions in the Fraser River drainage and the enlargement of Gross Reservoir. Initially, the loss of riparian timber stands and reduction of associated terrestrial prey species could reduce the peregrine falcon's use of these areas. However, peregrine falcon hunting and nesting around Gross Reservoir may increase following the re-establishment of mature riparian timber stands along the expanded shoreline (40 to 60 years).

The inundation of 35 miles of streamside riparian habitat, particularly the seven miles along the North Fork of the South Platte, could also impact the peregrine falcon. The historic use of the study area by this raptor species could be reduced.

Enlargement of Gross Reservoir should have no impacts on the population of greenback cutthroat trout, a federally endangered species, in the North Boulder Creek watershed (personal communication, CDW 1977).

Since the Concept A study area encompasses a broad vegetative spectrum, one or more of the plant species on the proposed federally endangered listing could be impacted.

Since the status of the State endangered Canadian lynx and wolverine within the Concept A study area is unknown (personal communication, CDW 1977), impacts to these species cannot be determined.

Also, the nationally threatened grizzly bear, endangered gray wolf, and black-footed ferret are no longer thought to exist within the Concept A study area and no impacts are anticipated (personal communication, CDW 1977).

Socio-Economic Conditions, Recreation, and Cultural Resources. The construction of Two Forks Dam and Reservoir in the South Platte River system would necessitate the relocation of the communities and settlements of South Platte, Dome Rock, and Longview. All of these are listed on the National Register of Historic Places and are within the North Fork Historic District and thus under the protection of Section 106 of the Historic Preservation Act of 1966 and would require statements of effect prior to disturbance. Twin Cedars, Oxyoke, Trumbull, and Deckers do not appear to qualify for the Register; Nighthawk does appear to qualify, and thus would be under 106 protection.

The total population of these communities is approximately 100 full-time residents and approximately 700 part-time residents. Relocations would also involve 5 miles of roads, 22 miles of power transmission lines, and 25 miles of telephone lines.

The existing recreation facilities that would be inundated by the new reservoir include 12 campgrounds, 35 picnic units, about 1/2 mile of access road, 3 miles of unsurfaced trails, and about 1 acre of parking facilities.

Impacts of the construction of the Two Forks Dam would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

Some present popular and heavily used recreation streams would be inundated by the reservoir, including about 19 miles of the South Platte River, 7 miles of the North Fork of the South Platte River, and about 9 miles of miscellaneous creeks and gulches. The present stream-oriented recreational use of approximately 240,000 annual visitor-days would be eliminated by the construction of this dam and reservoir and replaced with minimum-use reservoir-oriented recreation facilities. The present public access and use of the 8.6 mile reach of the South Platte River (Waterton Canyon) below Two Forks Dam would not be permitted.

The DWB and the U.S. Forest Service (USFS) would be subjected to substantial public pressure to more fully develop the reservoir and lands for more recreation. The reason for the pressure is the substantially unsatisfied recreation demand for water-oriented activities within the Denver metropolitan area.

Two Forks Reservoir, with its limited use recreation plan, could control crowded conditions into selected areas, and would therefore have the potential to provide some wilderness type solitude for those who want to retreat from urbanism.

The recreation plan would require strict control of the number of people entering and using the area and frequent facility repair or replacement. Without such actions, low quality recreation experiences for visitors could result. Litter and sanitation problems, and rapid soil and vegetation deterioration can also be expected.

Two Forks Reservoir would tend to attract land speculators and developers because of the high quality of the setting. Communities such as Buffalo Creek and Pine (both on the National Register and under 106 protection) would grow, which would place a severe burden on existing civic facilities. Second homes, rental cabins, and trailers would occupy private unzoned lands adjacent to the Two Forks right-of-way land. Those lands with outstanding vistas would draw premium prices. However, the dominance of surrounding Forest Service lands would tend to control some of the land speculation and development.

If few people fish in the reservoir, stocking may not be justified. Natural fish reproduction would not be very good because of the reservoir morphometry and limited littoral zone. Water fluctuation would also discourage natural reproduction. There could be no ice-fishing except during exceptionally cold winters when ice of sufficient thickness would form.

Although waterfowl and some game species may be attracted to water, administrative policies would discourage the development and management of land for wildlife propagation and staging. Hunting on or near the reservoir is not expected to be good and also would probably be discouraged.

Under limited use and controlled conditions, Two Forks could provide an excellent opportunity for nature study and photography. Educational institutions may be able to use the Two Forks Reservoir area as an outdoor laboratory for ecological studies.

Antero, Elevenmile, and Cheesman Reservoirs and the South Platte River from Antero to Two Forks would be operated in such a manner to retain higher water levels for longer periods of time. Concept A proposes using the west slope water first, holding the less reliable South Platte system in reserve. The maintenance of higher water levels for longer periods of time could attract recreationists. Theoretically, the larger water surface would be able to accommodate more boating than at present, when the reservoirs are drawn down more. The success in reservoir fishing would be a key factor in the increased use because the water is too cold for contact activities. Along with the possible increase in fishing would be an increase in sailing, camping, and picnicking around the reservoirs.

Cheesman would no longer be the terminal storage of municipal and industrial water for Denver when Two Forks is in place. This means it could be opened for more recreation activity, including boating, fishing, water skiing, picnicking, camping, group camping, hiking, nature study, and limited swimming. The amount of use would be limited by available facilities and administrative policies. Its full recreation potential would be less than the statistics previously shown in Table 8-6.

The cultural and social characteristics of the local population remaining in the area would be altered. Many people required to move would find relocation difficult to accept and an incalculable personal loss.

The beneficial social effects in the Upper South Platte area would include increased real income during construction, primarily to semi-skilled and unskilled minority workers. Following construction, other persons would benefit financially through increased recreation oriented economic activities. Management of the recreation and fish and wildlife facilities would upgrade health and safety conditions.

Construction of Two Forks Dam and Reservoir would inundate roughly half of the land area of the North Fork Historic District (National Register of Historic Places, October 9, 1974).

These historic components would be destroyed outright through construction and inundation, or relocated. While certain types of structural ruins may actually be preserved by covering waters, the inundation would have an overall negative effect on historic properties within the high water boundary of the reservoir (Feldman 1976 and Emrick 1976). Evaluation of impact on historic components above the high water line is as follows:

1. Such components would have their setting drastically altered in terms of topography, vegetation, and related components.

2. Visitors could cause damage to those components remaining above high water lines.

3. Alternatively, a well managed cultural resources program could provide protection for those components remaining above high water line and provide a valuable educational/recreation experience for visitors to the reservoir. This possibility is minimized, because most of the structures adaptable to interpretation, are below the high water line.

In summary, the historic losses would be greatest in that portion of the Two Forks Reservoir that would inundate roughly half of the North Fork Historic District.

Recent archeological investigations within the South Platte impact area have provided a base for further research into the nature of early man's existence in the region. This has been articulated in a series of hypotheses about early man's activities in the area and about broader questions of cultural process. Mitigation of these resources through systematic excavation and analysis would provide an excellent opportunity to thoroughly study these questions.

Construction of Two Forks would destroy the physical aspects of the research base necessary to enlarge upon these hypotheses. Despite this destruction, it is questionable whether destruction by project construction would have an overall negative effect upon the resource. Private construction and unauthorized removal and/or destruction of antiquities make long-term survival of these resources questionable. The choice essentially becomes one of systematic beneficial removal through mitigation, or non-productive removal through non-federally controlled construction, and/or "pot hunting."

Further studies would be required to more properly assess the loss in scientific, educational, and monetary terms.

Construction of the Straight Creek facilities in Roberts Tunnel System would not require relocation of property or people. Since the diversion conduit would be underground, adverse impacts to the natural scenic value of the area would be minimized.

The construction work force would probably live in the Dillon area, causing temporary increased demands on community services.

Since the average flow of Straight Creek would be reduced 88 percent, the fishery quality below the diversion structure would suffer; however, the beaver ponds and the upper part of the creek should still be good fishing for brook trout. Although less water would be entering the Blue River below Dillon Dam, the remaining flows should continue to provide a stockable stream for rainbow, brown, brook, and cutthroat trout. The fishery should remain fair to good (Kelly 1975), and the fishing pressure should not change because of Concept A development.

Green Mountain State Park, which includes Green Mountain Reservoir and the surrounding terrain, received approximately 165,000 visitor days use in 1976. Seasonal fluctuations in the pool level would adversely affect recreation use of the reservoir. The actual losses in visitor days that would result cannot be quantified.

Impacts of the construction of Straight Creek facilities would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

Depending on the degree and time of year of drawdown, the recreation use of Dillon Reservoir could decline from present visitations. Less surface acreage would be available for water-oriented recreation activities (e.g., power boating, sailing, and fishing) during late summer and early fall.

Exposed reservoir bottom land would contrast with the surrounding conifer-aspen forests, detracting from the visual qualities of the Dillon Reservoir area.

The reduction in recreation activities on the reservoir and the increased exposed bottom lands could depreciate the value of newly constructed condominiums, which depend heavily on the Dillon area's aesthetic and recreation qualities. This would make some developments difficult to sell and discourage future development of similar type units.

No significant impacts to known historic or prehistoric resources are anticipated in the Straight Creek or Dillon Reservoir impact areas. However, further studies will be required within these areas and an E.O. 11593 survey would be required. Streams such as Straight Creek and the Blue River that would experience decreased annual flow would have to be surveyed after the project is in operation. Such a decrease in flow could cause some cultural sites to be exposed to nonalluvial weathering and destruction due to increased visitor access. There is no economical way to survey and/or mitigate these latter sites before the project is in operation.

Gross Reservoir enlargement in the Moffat System would not require relocation of real property, roads, or people.

The temporary influx of construction forces in the area would have minimal or no impact on services provided by local communities.

Impacts of the enlargement of Gross Dam would probably exceed BLM criteria for maximum visual contrast; the nature of the impacts would be comparable to those described for similar elements of the proposed action.

The increased water diversion by the western slope collection system would significantly reduce flow and associated riparian habitat on about 55 miles of high mountain streams. This would adversely impact the scenic, cultural, and recreational value of these streams.

The Williams Fork-Fraser River systems would have their drainage flows reduced 30 percent and 90 percent, respectively. There are many good holes and riffles producing one of the better fly-fishing areas for rainbow and brook trout. The Fraser River and its tributary flow would be reduced from 60 to 65 cfs. The associated fair-to-good fishing would be lost. Both streams contribute to the quality of other recreation experiences. The quality of hiking, nature study, horseback riding, and picnicking would be degraded.

Enlargement of Gross Reservoir could increase the recreation potential of the reservoir. Improved fishing would attract more fishermen, provided the non-game fish population is reduced. Heavy use of the recreation facilities could result from an improved fishery. Gross Reservoir could expand its present use from shore fishing only to camping, picnicking, and possibly boating. Shore fishermen could continue to have access to the reservoir, but might be discouraged by the great increase in muddy shores resulting from frequent drawdowns.

Flows in South Boulder Creek would increase from 72.5 to 144.5 cfs. However, this additional volume of water would not improve the fishing between the Moffat Tunnel's east portal and Rollinsville because there is no way to stock the stream (Kelly 1975); the present fishery is poor. No impacts to historical or prehistorical resources are anticipated within the Gross Reservoir and west slope collection system impact areas. However, compliance with E.O. 11593 survey will be required in the area of the increased waterline.

As discussed under the Roberts Tunnel system, decreased streamflows could cause some cultural sites to be exposed. Increased streamflows, for example in South Boulder Creek, could also inundate cultural resources. There is no economical way to survey and/or mitigate these potential losses before the project is in operation.

Concept B

General

Concept B, shown on Map 8-2, would be the same as Concept A, except that the existing Corps of Engineers Chatfield Dam and Lake would be enlarged to accommodate east slope municipal and industrial terminal conservation storage, in lieu of building the potential Two Forks Dam and Reservoir for this purpose.

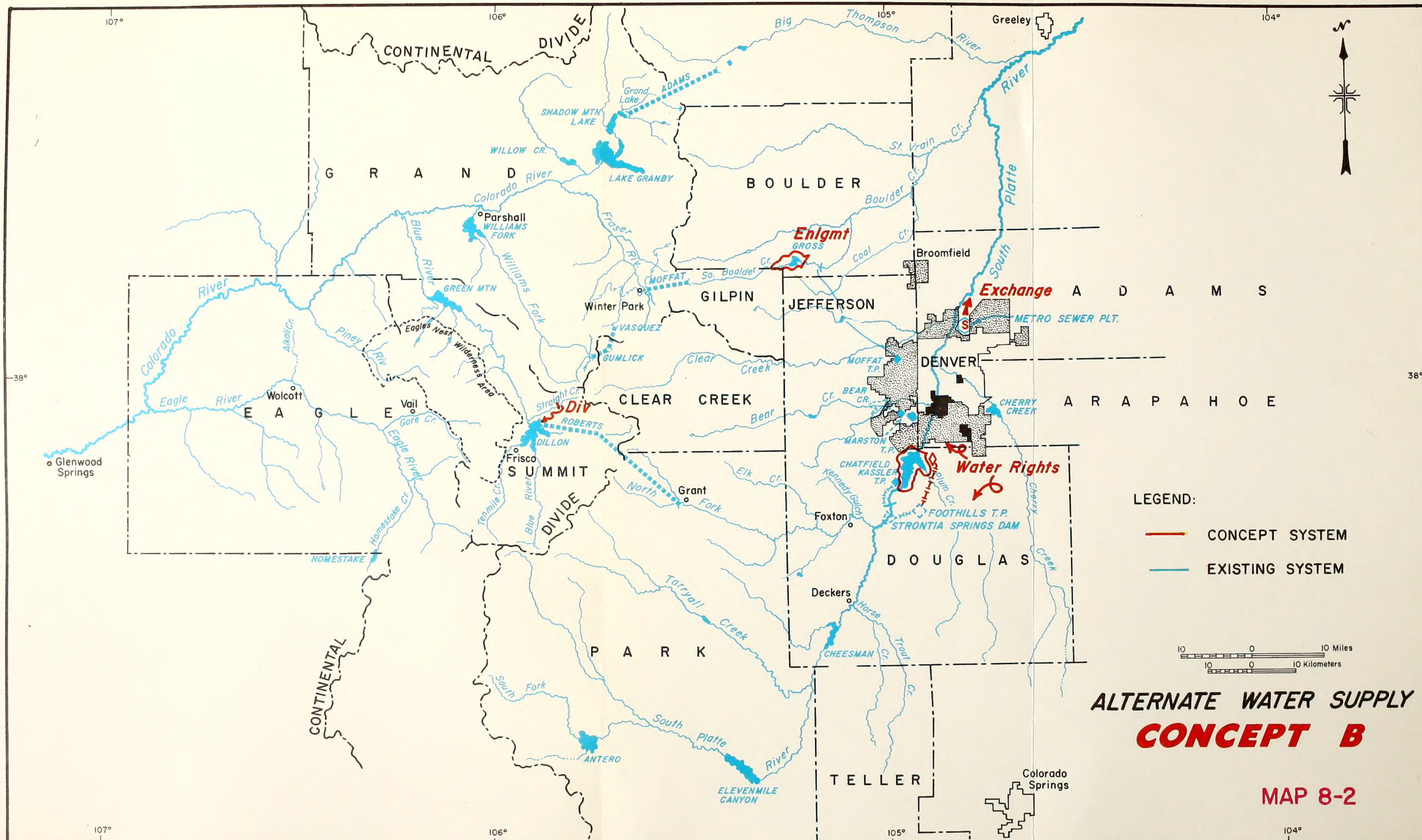
The features and plans of Concept B, like those of Concept A, would be enlargement of the existing Gross Dam and Reservoir, additional Blue River water diversion facilities (Straight Creek collection system), the acquisition of new water rights, and the exchange of treated Denver sewage effluent for agricultural water.

The description of the like features, their operations, and environmental impacts are given under the discussion of Concept A; therefore, they are not repeated here.

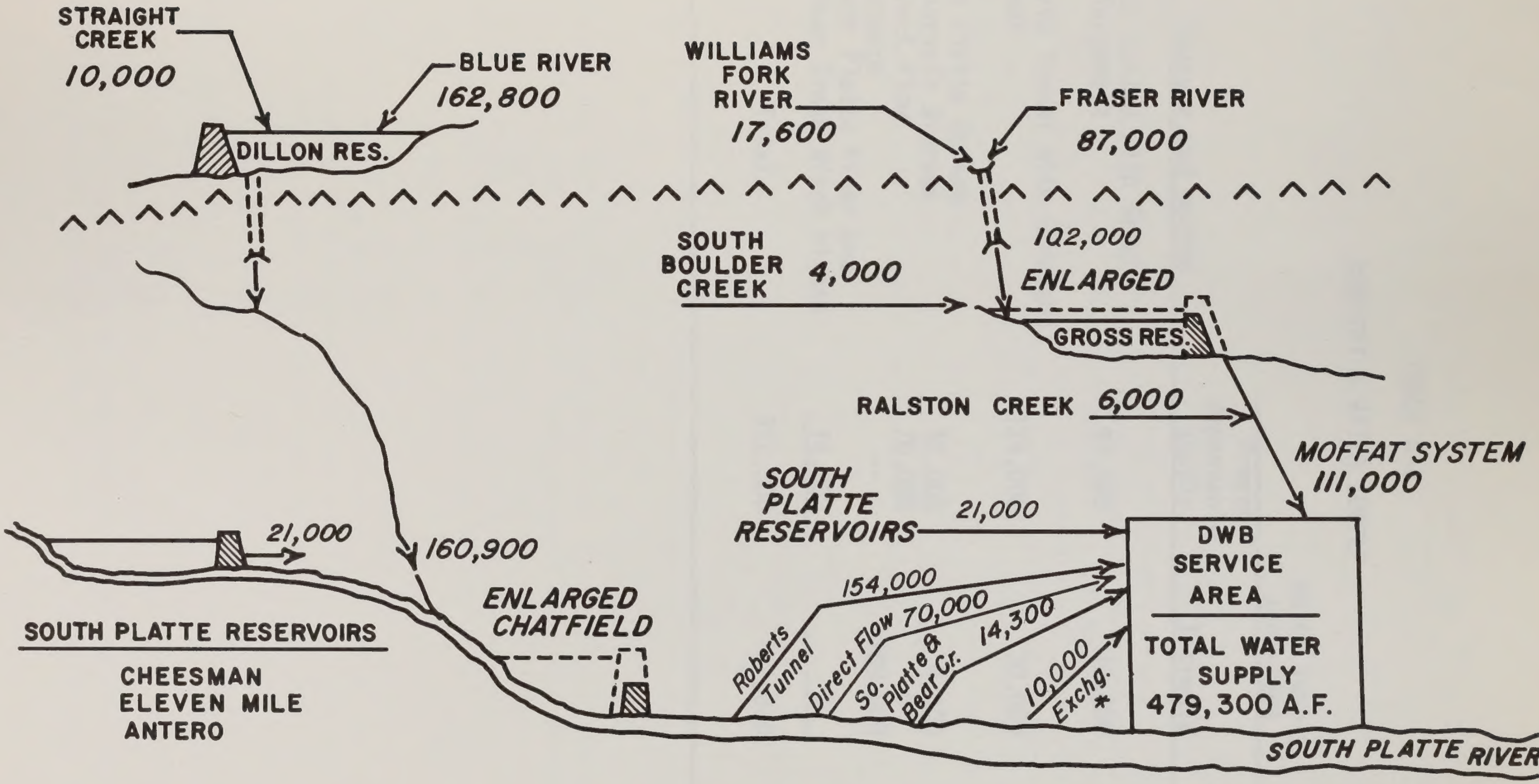
The combination of Concept B features and operational modifications would provide about 479,300 acre-feet total of raw water to the Denver metropolitan area, as shown on Figure 8-4 and Table 8-8.

In Concept B, Chatfield Dam and Lake would be used as the principal east slope facility for storing municipal and industrial water for treatment by the Foothills Treatment Plant, and eventual use in the Denver metropolitan area. The enlargement of Chatfield Dam and Lake would also provide for flood control downstream of the structure, and minimal recreation facilities would be constructed. Congressional authorization would be required to modify the existing Chatfield Dam and Lake to provide for new or revised project operations or functions.

About 305,000 acre-feet of storage capacity would be adequate to regulate the South Platte and Blue River flows as well as store and regulate agriculture water purchased and exchanged for treated sewage effluent from the Denver metropolitan area. In arriving at this concept, three options for using Chatfield were considered. These were: (1) eliminating the present flood control capacity in Chatfield Lake completely and drastically reducing the surcharge capacity, using this space for municipal and industrial conservation



CONTINENTAL DIVIDE
GRAND
BOULDER
GILPIN
JEFFERSON
ADAMS
DENVER
ARAPAHOE
CLEAR CREEK
EAGLE
SUMMIT
PARK
DOUGLAS
TELLER
Greeley
Broomfield
Parshall
Winter Park
Wolcott
Vail
Frisco
Glenwood Springs
Grant
Foxton
Deckers
Colorado Springs
SHADOW MTN LAKE
Grand Lake
ADAMS
WILLOW CR.
LAKE GRANBY
WILLIAMS FORK
GREEN MTN
MOFFAT
VASQUEZ
GUMLICK
ROBERTS
DILLON
HOMESTAKE
ANTERO
ELEVENMILE CANYON
CHEESMAN
MOFFAT T.P.
BEAR CR.
MARSTON T.P.
CHATFIELD
KASSLER T.P.
FOOTHILLS T.P.
STRONTIA SPRINGS DAM
METRO SEWER PLT.
CHERRY CREEK
GROSS
Enlgmt
Exchange
Div
Water Rights
S
Eagles Nest Wilderness Area
South Platte River
Colorado River
Eagle River
Blue River
Fraser Riv.
Williams Fork
Big Thompson River
St. Vrain Cr.
Boulder Cr.
Coal Cr.
So. Boulder Cr.
Clear Creek
Bear Cr.
Elk Cr.
North Fork
Tarryall Creek
Horse Cr.
Trout Cr.
Cherry Creek
Plum Cr.
Kennedy Gulch
Piney Riv.
Alkali Cr.
Gore Cr.
Homestake Cr.
Tenmile Cr.
Straight Cr.
South Fork
107°
106°
105°
104°
38°
LEGEND:
CONCEPT SYSTEM
EXISTING SYSTEM
10 0 10 Miles
10 0 10 Kilometers
ALTERNATE WATER SUPPLY
CONCEPT B
MAP 8-2



*Exchange includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT B

Rev. 5/13/77

FIGURE 8-4

TABLE 8-8

CONCEPT B WATER SUPPLY

Feature and source	Water Supply acre-feet: Present dependable supply	Increase	Concept B Total
Moffat system with Gross enlargement	92,000	19,000	111,000
Roberts Tunnel with Straight Creek	124,000	30,000	154,000
South Platte System			
Reservoir Storage	12,000	9,000	21,000
Direct Flow	70,000	0	70,000
Exchange	--	109,000	109,000
South Platte River and Bear Creek Ditch rights	14,300	0	14,300
Total	312,300	167,000	479,300

storage, (2) replacing the flood control storage with municipal and industrial conservation storage and constructing dams upstream on Plum Creek and the South Platte River for flood control purposes, and (3) enlarging Chatfield Dam and Lake to include 305,000 acre-feet of municipal and industrial conservation storage in addition to the existing 215,000 acre-foot flood control capacity, 120,000 acre-foot surcharge capacity, and 20,000 acre-foot sediment capacity.

There would be a number of detrimental effects associated with any of the above options. Using Chatfield Lake as a terminal municipal and industrial water supply reservoir would greatly increase the cost of treating the water. Water stored in Chatfield Lake would have to be pumped back upstream to the Foothills Treatment Plant. Strict environmental controls would be necessary to handle waste from the recreation facilities, weed control operations, and general maintenance of the recreation lands around the reservoir. Recreation opportunities would be greatly reduced, as no motor boating, swimming, or other body contact recreational activities would be permitted. Many permanent facilities, including highways, railroad, power lines, and houses, would require relocation because of the wide fluctuation of the reservoir water surface elevation.

In addition to the above, eliminating the flood control capacity and replacing it with municipal and industrial conservation capacity, as suggested in alternative (1) above, would probably necessitate new flood control operation procedures and require greatly increased channelization through the Denver metropolitan area.

The second alternative, in which flood-control dams and reservoirs would be constructed upstream and the flood-control capacity in Chatfield Lake would be converted to municipal and industrial conservation, would involve considerable cost from the construction of new structures. Environmental and social impacts from the construction would be extensive.

Significant costs and socio-economic impacts would also result for alternative (3), whereby the dam and lake would be enlarged to accommodate the additional conservation capacity.

Description

Features and Operations

The third alternative of enlarging Chatfield Dam and Lake was selected for inclusion as part of Concept B because it would still

retain the flood control function of the existing structure, provide municipal and industrial water storage and regulation, and have fewer environmental impacts than constructing flood control dams upstream. The following tabulation gives statistical data on the present and enlarged (Concept B) Chatfield Dam and Lake (Table 8-9).

Closure of the present structure occurred in 1973. It is an earth-filled dam about 150 feet high and 13,340 feet long. The proposal to add about 305,000 acre-feet of conservation space would require adding 42 feet to the height and 3,660 feet to the length of the dam. The total reservoir capactiy would then approach 660,000 acre-feet. Present assigned capacity for sediment, flood control, and surcharge would remain unchanged. The enlarged reservoir would require an additional 3,500 acres of rights-of-way. About 100 acres of land would also be required to construct underground conduits and the pumping plant to transport water from Chatfield to the Foothills Treatment Plant.

Enlargement of Chatfield Dam and Lake would require major relocations of existing real property and inundation of several thousand acres of lands adjacent to the reservoir now being subdivided for residential and light industrial uses. Relocation would include the community of Waterton and the DWB Kassler water treatment plant, approximately 9 miles of the Highline Canal, 4.6 miles of State Highway 75, 1.5 miles of Deer Creek Canyon Road, and 4 miles of county roads. In addition, relocation of railroads, transmission lines, natural gas lines, and water supply facilities would be required.

A pumping plant and buried conduit would be necessary to convey water from Chatfield Lake to the proposed Foothills Treatment Plant. The pumping plant would be located on the right embankment of Chatfield Dam and would have a capacity of 750 cfs with the pool at the minimum elevation of 5,426 feet. Two parallel 84-inch-diameter conduits would transport the pumped water 6 miles southwest to the Foothills Treatment Plant. The pumping plant would be designed for a total dynamic head of 550 feet, and would require a maximum electric power demand of 55 megawatts. The parallel conduits would pass beneath the enlarged Chatfield Lake for a distance of approximately one mile.

The enlarged reservoir would regulate waters from the Blue and South Platte Rivers, provide for better use of the DWB direct flow rights, agricultural water rights purchased, and agricultural water obtained in exchange for treated sewage effluent from the metro sewage plant. The reservoir would reach its maximum surface elevation each June, followed by a steady decline to a minimum elevation sometime in December. The water level would fluctuate between elevations 5,517 and 5,485 annually and could drop to 5,426 during periods of extreme droughts or floods.

TABLE 8-9

CHATFIELD DAM AND LAKE

	Existing	Enlarged
Total capacity (acre-feet)	355,000	660,000
Surcharge capacity (acre-feet)	120,000	120,000
Flood control capacity (acre-feet)	215,000	215,000
Conservation capacity (acre-feet)	0	305,000
Sediment capacity (acre-feet)	20,000	20,000
Maximum water surface elevation (feet msl) 1/	5,522	5,563
Top of conservation (feet msl) 1/	5,426	5,517
Area at top of conservation (acres)	1,150	5,826
Additional rights-of-way (acres)	____	3,500
Top of dam (feet msl) 1/	5,528	5,570
Crest length (feet)	13,340	29,000 2/
Height of embankment (feet)	150	192
Additional inundated streams (miles)		
South Platte River	____	5
Plum Creek	____	3
Deer Creek	____	1
Shoreline (miles)	10	26
Conservation pool fluctuation (feet)	4	91

1/ msl = mean sea level.

2/ Includes 12,000 foot dike section.

Chatfield Lake would store water originating in the South Platte Basin as well as west slope water transported through the Roberts Tunnel. An average of 160,900 acre-feet annually would be diverted through Roberts Tunnel and conveyed by the North Fork of the South Platte River. Flows downstream of Strontia Springs Dam would be dependent on the operation of the Foothills Treatment Plant. Flows would be at least equal to those necessary to meet downstream senior water rights not involved in exchange; generally, flows would be greater, as waters would be stored in Chatfield Reservoir.

Raw water would be diverted from the lake to a pumping plant and from there to the Foothills Treatment Plant, located about 6 miles southwest of Chatfield Dam. The pumping plant would be operated in one of two ways, (1) to supply, as a base load plant, a constant supply of water to the Foothills Plant for treatment, (2) or to deliver water to a peaking facility, pumping large quantities of water from May through September to meet the peak water demands.

Chatfield Lake contains water of relatively high quality (Corps of Engineers 1974). The water quality of the South Platte River is monitored at the Kassler Water Treatment Plant by DWB. Results of this monitoring show that the water is within the water quality criteria for raw water for municipal use (DWB 1973, 1974, 1975, and 1976).

As with Concept A, restrictions on public use including elimination of body contact sports and limitation of boating to nonpower craft would be necessary to protect the quality of the water. Sewage treatment facilities for minimum base recreation facilities would be required to eliminate contamination of water. Insecticide and other chemical treatments within the immediate area would be prohibited. Strong anti-litter control measures would be enforced.

Under Concept B, Cheesman Reservoir would continue to provide terminal storage for Denver's South Platte River water supply. Maximum water storage in the existing South Platte River reservoir system, Cheesman, Elevenmile Canyon, and Antero, would be maintained in the highest reservoir whenever possible, to optimize yield on a long-term basis. Minimum river releases below each reservoir would be provided to meet senior downstream water rights. Diversion of flows into the North Fork channel would be coordinated with natural flow conditions to minimize degradation and flooding.

Present Environment

The description of the environment for the Gross Reservoir enlargement, Williams Fork-Fraser River collection system, and Straight Creek-Dillon Reservoir collection system are included under Concept A, and will not be repeated for Concept B.

Soils and Terrestrial Resources. A belt of hogbacks divides the South Platte River Basin into two geologic regions. The region to the west of the steeply tilted ridges of sedimentary rocks (sandstones, shales, limestones) is primarily underlain by igneous and metamorphic rocks, including granites, schists, and gneisses. The region to the east of the hogbacks is underlain by deposits of compact sands, silts, and clays (Corps of Engineers 1974).

The South Platte River Valley in the vicinity of Chatfield Lake has been built up through the deposition of alluvial materials, mainly sands, gravels, and sandy clays derived from the weathering and erosion of the parent materials in the foothills and mountains to the west. On the east slope of the valley, the materials consist chiefly of sands and gravels with an occasional layer of silty or clayey sand. The overburden on the east slope is approximately 50 feet thick (Corps of Engineers 1974).

A more detailed description of the general soil types in the Chatfield Lake vicinity, based on the Soil Conservation Service's Range Site Descriptions, is included for Concept A.

The shortgrass plains ecosystem is predominate in the vicinity of Chatfield Lake. Intermittent watercourses, known as arroyos, crisscross the plains, providing sheltered habitat for the growth of shrubs and forbs. Perennial drainages, including the South Platte River and its primary tributaries, Plum, Bear, Clear, Sand, and Cherry Creeks, support characteristic riparian stands of cottonwood and willows.

Blue grama and buffalo grasses are the principal vegetative constituents of the shortgrass ecosystem. Growing no more than 16 inches tall, the shortgrasses form relatively shallow but very dense sods. The tawny swards of buffalo grass and bright green clumps of blue grama are liberally mixed with other short and mid-grasses including wheatgrasses, little bluestem, June grass, prairie dropseed, muhly grass, and curly-leaved sedges. Cheat grass, a common invader species around Chatfield Lake, is indicative of severly deteriorated range conditions. The plains uplands are sprinkled with rabbitbrush, fringed sage, yucca, and prickly pear cactus. An assortment of wildflowers, mainly white- and yellow-flowered composites, add variety to the rolling landscape.

The arroyos support relatively dense growths of shrubs and forbs including chokecherry, gooseberry, currant, saltbush, compass flowers, dotted gay feather, penstemon, asters, goldenrod, locoweed, coneflowers, and bee plant.

Riparian vegetation in the study area consists primarily of plains cottonwood, several species of willows, alders, an occasional box elder, and a diverse understory of shrubs and forbs. The exception is Plum Creek, which has limited understory, due to overgrazing and the scouring effect of spring floods (Corps of Engineers 1974). A dense grove of large plains cottonwood trees is located along the South Platte River on the southeastern and southwestern sides of the existing flood pool boundaries. This flood plain forest is interspersed with expanses of open grassland. Other woody plants found in this grove include lanceleaf cottonwood, box elder, and several species of willows. Understory vegetation consists primarily of poison hemlock, Canadian thistle, slender wheatgrass, western snowberry, golden currant, woodbine, and wild grape. Slender wheatgrass, Canadian thistle, smooth brome, common cattails, bulrushes, and a variety of sedges dominate the vegetative complex of the forest clearings adjacent to the lake (Corps of Engineers 1974).

In the study area, riparian habitat along the South Platte River and its tributary streams supports limited populations of mule deer, upland game, and furbearers. However, the availability and quality of wildlife habitat around Chatfield Lake has suffered from the surrounding suburban development (Corps of Engineers 1974).

The cottontail rabbit is the most common upland game mammal. A few mule deer have been observed in the study area. The Fish and Wildlife Service (1966) reports that small populations of beaver, mink, and muskrat are also present. Neither hunting nor trapping are permitted within the Chatfield Lake boundaries due to the proximity of the Denver metropolitan area.

Other mammal species known to inhabit the study area include the white-footed mouse, black-tailed prairie dog, long-tailed weasel, meadow vole, red fox, raccoon, and skunk.

The most abundant game bird species in the area is the mourning dove (FWS 1966). Various ducks and geese also utilize Chatfield Lake and the South Platte River in the study area during fall and spring migratory periods.

The flood plain forest along the southwestern arm of Chatfield Lake supports 40 nesting species of birds. Members of the Denver Field Ornithologists have made regular field counts in the study area for several years. Avian population densities as high as 684 birds per 100 acres have been calculated (Corps of Engineers 1974). Such densities equal those of the highest populated avian habitats anywhere in the country (Corps of Engineers 1974). These high population counts are directly attributable to the abundance and diversity of nesting and feeding habitat in and around the cottonwood grove, and the relative scarcity of similar habitat in the vicinity (i.e., 5-mile radius) of Chatfield Lake.

Owls, hawks, yellow warblers, redstarts, vireos, and kingbirds nest high in the cottonwood canopy. Orioles, goldfinches, robines, and peewees nest in the middle elevations of this forest. Towhees, chats, MacGillivray's and Virginia's warblers, catbirds, and scrub jays nest in the shrubby understory. Pheasants and meadowlarks nest in the open grassland areas. Birds which nest in holes in dead trees include the flicker, downy woodpeaker, chickadee, house wren, starling, and screech owls.

Regular visitors to the grove, but not nesting there, are the killdeer, common nighthawk, belted kingfisher, barn swallow, black-billed magpie, and lazuli bunting. Irregular visitors are the violet-green swallow, cliff swallow, catbird, Audubon's warbler, Wilson's warbler, common grackle, red-winged blackbird, house finche, chipping sparrow, white-crowned sparrow, and song sparrow (Corps of Engineers 1974).

Aquatic Resources. Chatfield Lake is managed as a mixed warm and cold water fishery supporting largemouth bass, bluegills, crappies, and trout (Corps of Engineers 1974). The fishery in Chatfield is expected to be maintained entirely with hatchery-reared fish. There are also provisions for put-and-take fisheries in ponds created by sand and gravel operations in the upper end of the reservoir (Corps of Engineers 1974).

The aquatic system of the South Platte River and North Fork of the South Platte River have already been described for Concept A.

Important and Endangered Species. The previously described forest of plains cottonwood trees within the southern boundary of the Chatfield Lake project area contains a great blue heron (*Ardea herodias terganzi*) rookery. The presently active rookery covers approximately 27 acres.

There are golden eagle nests in the vicinity of Chatfield Lake. Bald eagles may also utilize portions of the study area during migratory periods, but none are known to nest there (personal communication, CDW 1977).

No Federal or State threatened or endangered mammals are known to exist in the study area (CDW 1976).

The endangered peregrine falcon has been observed in Jefferson and Douglas Counties and therefore may be found in the Chatfield Lake vicinity. The State, however, does not list the study area as essential hunting or nesting habitat for the peregrine falcon (CDW 1976).

The discussion of the status of threatened or endangered amphibians, reptiles, and plants in Colorado provided for Concept A is also applicable to all aspects of Concept B.

Recreation, Socio-Economic Conditions, and Cultural. The area around the existing Chatfield Dam and Lake is the fastest growing recreation complex in the Denver metropolitan area. Ultimately, the lake and surrounding public use facilities are expected to provide recreational opportunities for over two million visitors annually.

As presently planned (Corps of Engineers 1972), the minimum multi-purpose pool (elevation 5,426 feet) will have a surface area of 1,150 acres for water-oriented recreational activities. Thus water-use recreation will be divided into three separate areas on the lake.

1. Motorless boating area:
sailing, bird watching, hand powered boats, fishing and swimming.

2. Open boating area:
power boats, water skiing, and fishing.

3. Wakeless boating area:
5 hp or less sailing, fishing, hand-powered boats and swimming.

The ultimate land use plan (Corps of Engineers 1972) for those areas surrounding Chatfield Lake allocates recreational use in one of four separate categories. These categories are: (1) day use; (1) overnight use; (3) natural or environmental study use; and (4) open space.

Day use activities include picnicking, swimming and water skiing beaches, shoreline fishing, hiking, bicycling, playgrounds, boating, and sightseeing.

Overnight use areas will be used for trailer and group camping and for tent and walk-in type camping.

Areas that are ecologically worthy of preservation, enhancement, or interpretion will be used for natural or environmental study. These areas will remain relatively undisturbed with only minor development of trails to accommodate public use.

Open spaces are scenic areas, too rugged for development, and the buffer zones separating public highways from developed recreation areas. Minimum trail development will be provided for public use in these areas.

The existing visual environment for this concept is the same as described in Chapter 2, and in Chapter 8, Chatfield Alternative.

Bordering Chatfield Lake to the north and northwest are rapidly expanding residential complexes, which will soon surround the government land occupied by the reservoir right-of-way. To the south and west are industrial complexes and older homes, with farm lands still maintaining a precarious foothold. It appears that the remaining land will be occupied by industry and residential developments in the near future.

Two major industrial complexes are located west of the reservoir: Johns-Manville and Martin-Marietta. Modern highways provide easy access to the reservoir; railroad lines bisect the landscape; both are intermingled with the remaining, but diminishing, agricultural culture that once flourished here.

Two main studies have been completed for the historic cultural resources in the area in and around Chatfield Lake (Corps of Engineers 1972 and Emrick 1976). The first deals with prehistoric resources, and the second with historic resources.

The Corps of Engineers' studies done in 1965, 1966, and 1969, located 21 prehistoric sites with identifiable artifacts. Of these, 17 were within the maximum pool level of the present lake. Of the four

outside this line only one is deemed significant. This is K:12:14, an apparent Woodland site which was characterized by circular stone rings (probably tee-pee rings), a number of hearths, and a number of food procurement and preparation implements. In addition to this site, other archeological and paleontological remains have been unearthed during the past 30 years. Notable among these are the Lamb site (K:8:49), where a Mammoth skeleton and a disassociated Yuma type point were found (Wedel 1961, 1962, 1963, and 1964), and a fossil mammoth skull found during construction of the Chatfield Dam. This latter find is estimated to be between 120,000 and 200,000 years old. Based on the scanty evidence available, the area seems to have a human occupation of roughly 6 to 10 thousand years.

Emrick's 1976 survey located two historic sites that could be affected by the Chatfield expansion. One is outside the present high-water line of Chatfield Lake and inside the projected high water line for the proposed expansion. This is a portion of the Highline Canal, construction of which began in 1881. The second is the village of Waterton (formerly Wye), which originally was a station on the Colorado and Southern Railroad Line. It was later used to house workers for the Cheesman Dam construction. The village is within the maximum pool level of the present Chatfield Lake; the expansion would inundate it.

In addition to those properties cited by Emrick, there are two small farmsteads and a one-room schoolhouse located in a small valley in the Deer Creek area, within the conservation pool of the potentially enlarged reservoir. These structures date from about 1849. One of the two farmsteads is the Hildebrand Ranch, which is listed on the National Register of Historic Places.

Temporary construction access roads would be required to haul borrow material from south of the dam. Most borrow materials, including selected earth embankments and sands and gravels, could probably come from within the present Corps of Engineers' reservoir takeline, (outermost boundaries of land that must be acquired for the reservoir). These construction activities within the present reservoir area would cause a major impact for planned recreation facilities and use of Chatfield Lake.

Temporary unavoidable soil erosion from borrow areas and contractor haul spills could increase lake turbidity, which would reduce the quality of fishing as well as other water sport activities. Owing to the growing urbanization and human influence adjacent to the present reservoir takeline, the displacement of the remaining terrestrial wildlife should be minimal.

Construction of the pumping plant and underground conduit required to convey municipal and industrial water from Chatfield Lake to the Foothills Treatment Plant would disturb approximately 100 acres. The pumping plant would be located on the east embankment of the southeastern arm of the existing lake, primarily within the confines of an existing transportation and utility corridor. Presently, rights-of-way used for Denver and Rio Grande Western and Atchison Topeka and Santa Fe railroad lines, the Highline Canal, and a high voltage transmission line pass within ¼ mile to the east of the potential plant site. Due to this surrounding development, the amount of native terrestial vegetation and associated wildlife in the potential construction area is limited.

The water conveyance system would consist of 6 miles of two parallel, 84-inch-diameter buried conduits. One mile of this length would extend from the pumping plant, under the enlarged lake surface, to the opposite shoreline of the southeastern arm of the lake. From there, the structure would cross approximately 5 miles of shortgrass plains in a southerly direction, ascending 400 feet to the potential Foothills Treatment Plant near the existing Aurora Rampart Reservoir. This construction would require a maximum right-of-way width of 50 feet. The vegetative community would be temporarily disturbed by this action. Also, terrestrial wildlife would be displaced by construction activity and habitat destruction. The expanses of similar habitat (i.e., native shortgrass plains), both to the east and west of the potential construction corridor, should facilitate successful relocation of displaced animals. Following construction, the quality of the disturbed habitat could be restored by contouring and replanting of native vegetation.

Enlargement of Chatfield Lake would require the relocation of the existing Kassler Treatment Plant and 9 miles of the Highline Canal, 4.6 miles of Colorado Highway 75, 1.5 miles of the Deer Creek Canyon road, 4 miles of miscellaneous county roads, and 2 miles of high voltage transmission lines. Construction rights-of-way required for relocations would vary in width from 50 to 300 feet. As the specific nature of these relocations has not yet been determined, impacts to terrestrial vegetation and wildlife are difficult to determine. However, any relocation schemes would result in some disruption of habitat and displacement of animals. The degree of impact could be reduced by efforts to restore disturbed areas to natural conditions (e.g., recontouring, revegetation).

Changes in historical streamflow regimes could impact the abundance and diversity of riparian habitat along the South Platte River. The degree of impact would be contingent on timing and volume of flow increases.

Following construction, any trenches and borrow areas above the top of the conservation pool would be backfilled and shaped to blend with the natural surroundings.

Analysis

Environmental Impacts

The impacts associated with the Roberts Tunnel and Moffat Systems (west slope) are the same as described for Concept A. The impacts covered here (Concept B) are those involving enlargement and operation of Chatfield Dam and Lake to provide terminal municipal and industrial regulatory storage for the DWB's South Platte River system.

General. The following discussion is related to temporary construction impacts only. Long-term impacts follow under appropriate headings.

Construction and enlargement of Chatfield Dam would result in temporary, localized deterioration of air, noise, and water quality. Increases in noise and dust levels would be most disturbing to nearby residents. Soil erosion would increase turbidity in surface water flowing from the construction areas. Increases in dust, hydrocarbons, nitrogen oxide, and carbon monoxide would result from the operation of heavy construction machinery.

Major disruption of both vehicular and railroad traffic would occur during construction. Temporary detour routes for State Highway 75 and U.S. Highway 85, and for the Denver and Rio Grand Western, and Atchison Topeka and Santa Fe Railroads would be required around the construction (enlarged) area of the dam.

Terrestrial Resources. The surface area of Chatfield Lake at the maximum conservation pool elevation would be increased from 1,150 acres to 5,826 acres; this enlargement would inundate at least 4,676 acres of existing terrestrial vegetation and associated wildlife habitat. In addition, this action would flood riparian vegation along 5 miles of the South Platte River, 3 miles of Plum Creek, and 1 mile of Deer Creek.

The primary vegetative types affected would be the shortgrass plains of the existing lake uplands and the cottonwood-willow association of the riparian and flood plain areas.

Terrestrial wildlife would be displaced by the potential action. If similar habitat is available within a reasonable migratory distance (i.e., according to the particular species being considered), displaced wildlife should be able to successfully relocate. Animals which cannot successfully relocate could perish. Two factors must be considered in determining the degree of impact to terrestrial wildlife. With the exception of avian fauna, wildlife populations in the Chatfield Lake vicinity have been reduced by the surrounding suburban and industrial development. The impacts on sheer numbers of wildlife should be less than would occur if the existing lake was situated in a more rural setting. However, the encroachment of civilization has also reduced the availability of adjacent similar habitat. Thus, relatively speaking, the wildlife that are displaced should have difficulty relocating.

Before inundation, the majority of trees comprising the flood plain cottonwood forest along the southwestern arm of the lake would be cut and removed. This action would eliminate part of one of the most densely populated avian habitats in the country (Corps of Engineers 1974). Due to the lack of similar habitat within a 5-mile radius of the study area, displaced birds, particularly nesting species, would have difficulty relocating. Affected avian fauna which can migrate over long distances and adapt to varying habitat conditions should be able to successfully relocate.

During normal water years, the reservoir surface would fluctuate 32 feet between elevations 5,517 and 5,485. The general operational pattern would provide for a maximum water surface elevation sometime in June, with a steady decline to a minimum water surface elevation in December. During periods of extreme drought or heavy spring runoff, the reservoir surface could fluctuate as much as 91 feet (between elevations 5,517 and 5,426) during any given year.

These potential changes in the range of conservation pool fluctuation, from the existing annual average of 5 feet, would promote the formation of extensive mudflats along the 26 miles of shoreline of the enlarged lake. Development of terrestrial riparian vegetation within these mudflats should be limited to annual weeds and grasses. Growth of perennial forbs, shrubs, and trees should be restricted by water level fluctuations, thus reducing the abundance and diversity of terrestrial wildlife populations in the Chatfield Lake vicinity. However, the proposed operational pattern could improve waterfowl nesting and feeding habitat within the lake boundaries.

Aquatic Resources. Under this concept, diversions would take place in the same streams as in the previous concept. Impacts in the collection system would be identical to those previously described.

Under Concept B, water that could not be diverted at Strontia Springs would pass down Waterton Canyon to Chatfield Lake. The presently productive stream fishery of the Upper South Platte Canyon above the confluence would remain as it is. However, the fishery in Waterton Canyon would provide little or no return. As it stands now, this section of the river is difficult to fish during high water (International Engineering Corporation 1973). With increased flows, this situation would be agravated over a longer period of time.

An enlarged Chatfield Lake would provide a significant warm water fishery during its initial year of operation, because of the high biologic productivity from nutrients released from inundated soils. After reaching peak productivity and leveling out at a lower-than-peak-productivity, it would be necessary to stock the reservoir to meet the heavy fishing pressure.

Cheesman Reservoir would still provide terminal storage for Denver's water supply, therefore fishery management would not be required.

Under this concept, the diverted water would be identical in both quantity and quality, as was described under Concept A. As a result, the expected increase in salinity in the Colorado River would also be the same.

The water diverted for the Foothills Project will proceed through Dillon Reservoir, the Roberts Tunnel, and be stored in Chatfield Lake. The diverted water is of high quality, and would probably result in a relatively minor change in the water quality of the reservoir. A change would be a slight improvement in already high quality water. Therefore, it would still be suitable for municipal use with standard treatment technology.

The impact on the water quality of the South Platte River downstream from the metropolitan area would be about the same as under Concept A.

Important and Endangered Species. Enlargement of Chatfield Lake would eliminate the great blue heron rookery located in the upstream portion of the present multipurpose pool along the South Platte River. Prior to inundation, the cottonwood trees in the rookery would be cut and removed from the study area; this action would result in the loss of some members of this heron population.

The cutting of cottonwood groves and inundation of other riparian habitat could also reduce the value of the study area for nesting and hunting populations of golden eagles and peregrine falcons.

Recreation, Socio-Economic and Cultural. Chatfield Lake would have its capacity increased by 305,000 acre-feet. The lake size would increase from 1,150 to 5,826 surface acres at the top of conservation pool. The lake shoreline would increase from 10 to 26 miles, and an additional 3,500 acres of land would be acquired.

With full recreation development, as presently planned, Chatfield's 1,150 surface acre pool and surrounding land use facilities are expected to draw 2 million visitors annually. The larger pool of 5,826 surface acres and 26 miles of shoreline could accommodate substantially more visitors. The visitation can only be considered potential, because the proposed lake administration is to provide minimum recreation opportunities. The Corps of Engineers and DWB could expect to receive considerable pressure from local residents to lift recreation use restrictions on an enlarged Chatfield Lake.

The primary reduction in recreation activities, in utilizing an enlarged Chatfield Lake as a terminal municipal and industrial storage facility, would be those associated with water use. The main restrictions would apply to motor power boats, water skiing, and swimming. Other water use activities such as sailing, hand powered boating, and fishing would not be affected by restrictions, and these activities would tend to increase at a rapid rate. This situation would require strict control of the number of people using the lake surface. Without strict controls and enforcement litter and sanitation problems can be expected.

Related recreational land use activities and developments as described earlier for the present development could continue as planned. The existing recreation facilities would need to be relocated. Outhouse vaults would need to be sealed and new vaults built for any

relocated facilities. Boat launch ramps would be extended. Campgrounds, picnicking pads, and plumbing would be inundated. The overhead shade shelters would need relocating. Entrance and administrative buildings would also need relocating. Those facilities lost to inundation can be easily replaced; therefore, the losses are not considered a significant impact.

Enlarged Chatfield would usually have an annual fluctuation of 32 feet. The drawdown would inhibit fishing and shoreline activities during the latter part of the summer peak season. An extreme drawdown of 91 feet would reduce the number of participants in all activities, and the quality of experience would be degraded.

The volume of water coming down through the South Platte Canyon from the North Fork-Roberts Tunnel-Dillon System and the South Platte System would discourage stream fishing. The canyon would be unsuitable for fishing during periods of high flows.

The "chutes", swimming, tubing, canoeing, kayaking, and associated camping and picnicking would remain available to recreationists because it is upstream from the North Fork confluence. Biking, hiking, and motorcycling could also continue.

The enlargement of the existing Chatfield Dam and Lake would have both negative and positive impacts on the social, cultural, and economic aspects of the local community, and to a less extent on the Denver metropolitan area.

Construction activities would result in dust, noise, traffic congestion, and other disturbing influences. Certain light industry and residential property west and south of the present reservoir would be inundated or relocated. Power line structures and other services would be temporarily disrupted during the construction period.

Increasing the size of the Chatfield Dam and Reservoir will increase the visual impacts that have already occurred as a result of the dam's initial construction.

The inundation and displacement of local facilities as a result of the enlarged lake and right-of-way could be mitigated by reconstruction, relocation, and reimbursement. Kassler Treatment

Plant (1890) as a historical site could be flooded. When enlargement is completed, the social and cultural environment of the area would generally retrench to its present situations and trends.

The historic cultural sites to be affected by the enlargement of Chatfield Lake include the Highline Canal, the village of Waterton, Kassler Treatment Plant (1890), and the Hildebrand Ranch.

1. Highline Canal: The top of the planned conservation pool line is slightly below the canal alignment and it is probable that the canal would only occasionally be flooded. Recommended mitigation for this structure is to have it recorded by the Historic American Engineering Record.

2. Waterton: The village is at the very edge of the high water line of the present lake and would be within the proposed expansion high water line. The structures should be properly surveyed and evaluated if the lake is to be expanded.

3. Kassler Treatment Plant (1890): This facility could be within the potential reservoir and would have to be relocated on higher ground.

4. Hildebrand Ranch: The structures associated with this complex are among the oldest continuously occupied buildings in the State and they are on the National Register. As such, strong measures should be taken to protect them. They lie at the very edge of the maximum pool level and could be protected by a system of dikes. It is preferable to keep them in their present location.

Concept C

General

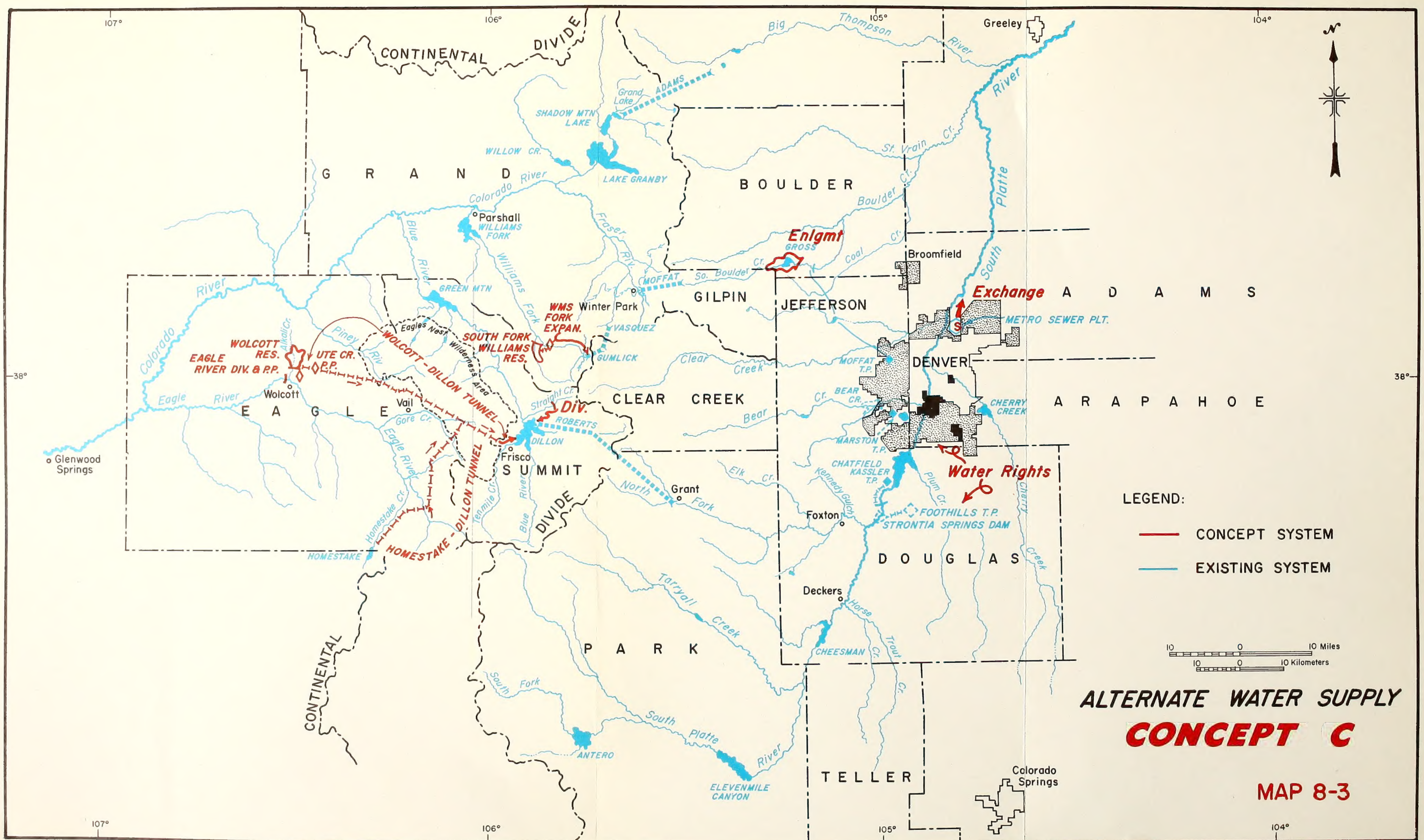
Concept C, shown on Map 8-3, would consist of a new water collection and storage system on the Eagle River to divert water into Dillon Reservoir (Roberts Tunnel System). It would also expand the existing Williams Fork collection system (Moffat System) and enlarge Gross Dam and Reservoir, provide new collection facilities on Straight Creek, purchase existing agricultural water rights for municipal and industrial use, and exchange treated sewage effluent from the Denver metropolitan area for agricultural water. Concept C would provide a total of approximately 494,300 acre-feet of water for municipal and industrial use by the Denver metropolitan area as shown in Figure 8-5 and in Table 8-10.

TABLE 8-10

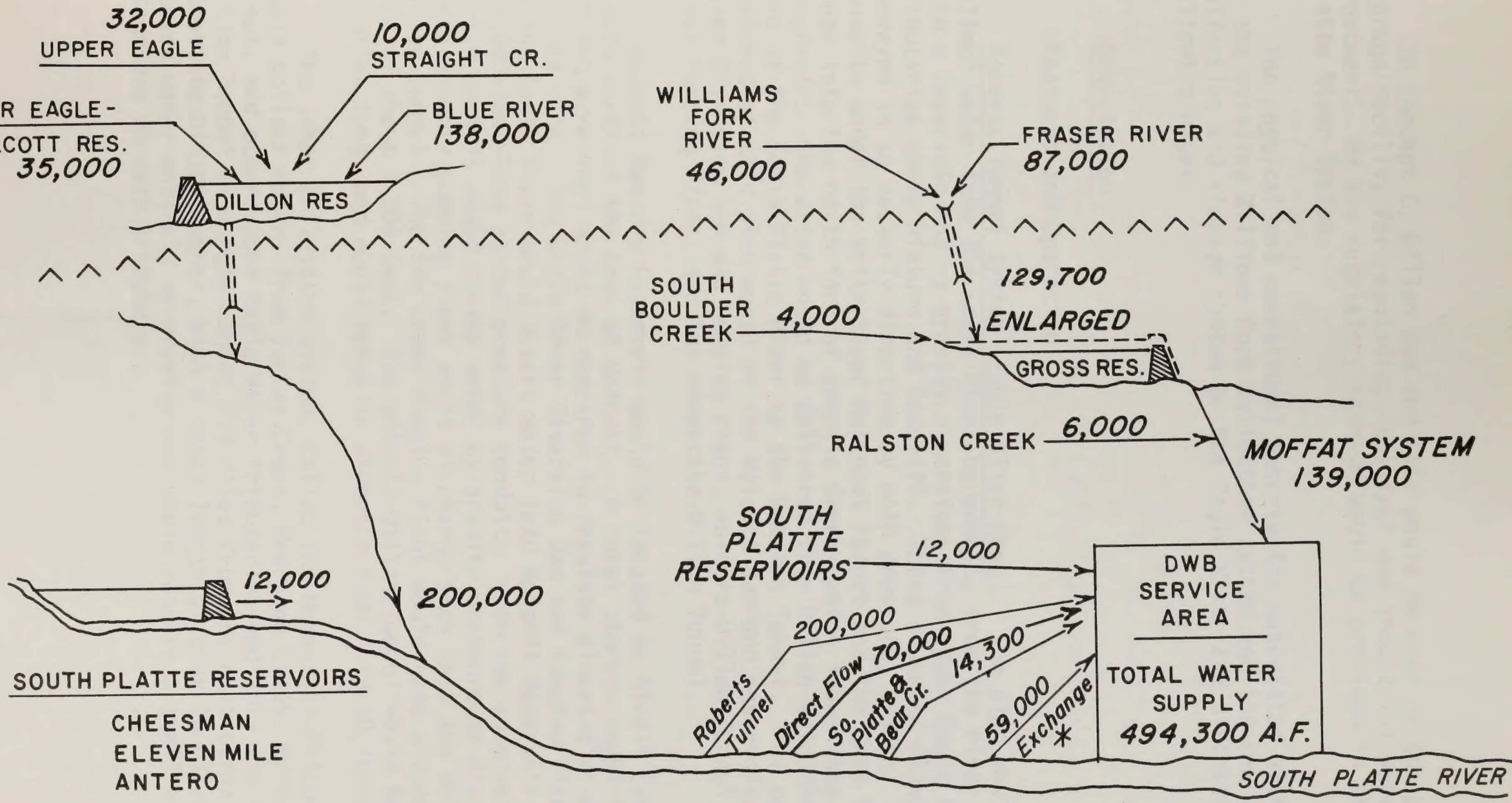
CONCEPT C WATER SUPPLY

Feature and source	Water Supply acre-feet: Present dependable supply	Increase	Concept C Total
Moffat system with Gross enlargement	92,000	47,000	139,000
Roberts Tunnel with Straight Creek and Eagle Diversion	124,000	76,000	200,000
South Platte System			
Reservoir Storage	12,000	0	12,000
Direct Flow	70,000	0	70,000
Exchange	-	59,000	59,600
South Platte River and Bear Creek Ditch rights	14,300	0	14,300
Total	312,300	182,000	494,300

Information on the physical and operation aspects of the enlarged Gross Dam and Reservoir, the collection facilities on Straight Creek, and the purchase and exhange of agricultural water rights given under the discussion on Concept A is also applicable to this concept; this information is not repeated here.



CONTINENTAL DIVIDE
G R A N D
B O U L D E R
GILPIN
JEFFERSON
A D A M S
DENVER
A R A P A H O E
CLEAR CREEK
E A G L E
S U M M I T
P A R K
D O U G L A S
T E L L E R
Greeley
Broomfield
Parshall
Winter Park
Wolcott
Vail
Frisco
Grant
Foxton
Deckers
Glenwood Springs
Colorado Springs
Enlgmt
GROSS
Exchange
METRO SEWER PLT.
Water Rights
WMS FORK EXPAN.
SOUTH FORK WILLIAMS RES.
WOLCOTT RES.
EAGLE RIVER DIV. & P.P.
UTE CR. P.P.
WOLCOTT - DILLON TUNNEL
HOMESTAKE - DILLON TUNNEL
Div.
ROBERTS
DILLON
HOMESTAKE
GREEN MTN
WILLIAMS FORK
LAKE GRANBY
SHADOW MTN LAKE
WILLOW CR.
ADAMS
MOFFAT
VASQUEZ
GUMLICK
MOFFAT T.P.
MARSTON T.P.
CHATFIELD KASSLER T.P.
FOOTHILLS T.P.
STRONTIA SPRINGS DAM
CHEESMAN
ANTERO
ELEVENMILE CANYON
CHERRY CREEK
Eagles Nest Wilderness Area
LEGEND:
CONCEPT SYSTEM
EXISTING SYSTEM
10 0 10 Miles
10 0 10 Kilometers
ALTERNATE WATER SUPPLY
CONCEPT C
MAP 8-3



* EXCHANGE includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT C

Rev. 5/13/77

FIGURE 8-5

In Concept C, Dillon Dam and Lake would be used as the principal storage facility for regulating municipal and industrial water for treatment. No new regulatory storage would be provided in the South Platte River System.

The physical and operational description associated with expansion of the existing Williams Fork collection system and the new water collection and storage system on the Eagle River are discussed in the following pages.

Description

Features and Operation

Roberts Tunnel System (Eagle River Area). The plan would be to collect water from the Eagle River by pumping from the river near Wolcott into a reservoir and by gravity diversions from upper Eagle River tributaries above Minturn and Redcliff. These diverted flows would be conveyed in an easterly direction by both pressure, gravity tunnels, and conduits under the White River National Forest and the Gore Mountain Range into the north fork of Tenmile Creek, which flows into Dillon Reservoir. The water would be delivered from Dillon into the north fork of the South Platte River by the Roberts Tunnel. The principal features of this plan would be the Wolcott Dam and Reservoir, Eagle River Diversion Dam and Pumping Plant, Wolcott-Dillon Tunnel and Ute Creek Pumping Plant, and the Homestake-Dillon Tunnel.

Wolcott Dam and Reservoir would be located on Alkali Creek about 1 mile north of the town of Wolcott. A total storage capaicty of 135,000 acre-feet would be required to regulate diverted river water at this site. The Eagle River Diversion Dam and Pumping Plant located on the Eagle River would divert water into Wolcott Reservoir through a 5,000-foot-long buried pressure conduit. From the reservoir, another buried conduit would convey water by gravity pressure to Ute Creek, where another pumping plant would discharge flow into the Wolcott-Dillon Tunnel. The Ute Creek Pumping Plant would have a total pump lift of about 2,000 feet. The Wolcott-Dillon Tunnel would be over 32 miles long, and would range in diameter from 7 to 10 feet.

The other collection system, called the Homestake-Dillon Tunnel, would collect waters from Turkey Creek, Wearyman Creek, Resolution Creek, and other upper Eagle River tributaries and join the Wolcott-Dillon Tunnel at a point about 6.9 miles from the exit portal. The Homestake-Dillon Tunnel, with a total length of over 26 miles, would convey water entirely by gravity and would require a small diversion structure on each tributary.

A statistical summary of these features is shown below:

TABLE 8-11

ROBERTS TUNNEL SYSTEM

Potential feature	Quantity
Wolcott Dam and Reservoir	
Total conservation capacity (TCC)	125,000 ac-ft
Total storage capacity	135,000 ac-ft
Surface area at TCC	1,505 acres
W.S. elevation at TCC	7,330 feet
Minimum river release	natural inflow
Height of dam (above streambed)	276 ft
Crest length of dam	2,700 ft
Elevation, top of dam	7,338 ft
Eagle River Diversion Dam and Pumping Plant	
Height of dam	27 ft
Crest length	225 ft
Elevation, top of dam	6,920 ft
Pumping plant capacity	840 cfs
Length of discharge line	5,030 ft
Wolcott-Dillon Tunnel	
Capacity	72 cfs
Length	172,705 ft
Diameters	7 to 10 ft
Pumping plants	Ute Creek (1)
Homestake-Dillon Tunnel	
Capacity (minimum to maximum)	1-340 cfs
Length (26.4 miles)	139,250 ft
Diameters, varies from	2.5 to 8.83 ft

At a point about 19 miles east of Wolcott Reservoir, the Wolcott-Dillon Tunnel would pass under the Eagle's Nest Wilderness boundary approximately 235 feet below the existing ground surface. From this point, about 12.9 miles of the tunnel would be constructed underground through the wilderness area boundaries. The tunnel would be constructed about 80 feet below the natural ground surface at the eastern wilderness boundary, which is approximately 1/2 mile west of the tunnel's east portal.

The Homestake-Dillon Tunnel would be 75 feet underground entering the wilderness area. From this point, the remaining 1.7 miles of tunnel would be an average of 150 feet below the Eagle's Nest Wilderness surface area to where it connects into the Wolcott-Dillon Tunnel. About 7 percent of the tunnel's total length would be constructed under the wilderness area.

About 5.5 miles of new highway would be required to be constructed to replace a portion of the existing State Highway 131 that would be inundated by the potential Wolcott Reservoir.

Wolcott Dam could be constructed with selected earth material from borrow areas just north of the damsite, and within the conservation pool. Excavation from the Wolcott-Dillon Tunnel, amounting to about 850,000 cubic yards, would be hauled out both the western and eastern portals as well as through three construction adits along the tunnel alinement. The eastern portal disposal area would be on DWB land adjacent to Dillon Lake. All other disposal areas would be outside the wilderness area. Excavation from the Homestake-Dillon Tunnel would be about 460,000 cubic yards. Disposal areas for this tunnel waste would be in the south portal area and through several construction adits, all of which would be outside the wilderness area boundary.

New 20-foot-wide gravel access roads required to build the above features would total about 12 miles. Access to the western end of the Wolcott-Dillon Tunnel would require about 4 miles of new road from relocated State Highway 131. In addition, about 6 miles of access road would be required to the Wolcott-Dillon Tunnel construction staging and adit areas from U.S. Highway 70 and 6. About 2 miles of improved and new access roads would be required to build the Homestake-Dillon Tunnel.

The average annual energy required for pumping at the Eagle River and Ute Creek plants would be about 117 million kwh. Electrical transmission facilities would consist of an additional 230/115 kV transformer, and about 3 miles of new 115 kV transmission line, from the existing Wolcott Substation to the Eagle River and Ute Creek Pumping Plants. This substation, located on the south side of Interstate Highway 70 near Wolcott, is owned by the Colorado Ute Electric Association. Power is transmitted to the existing substation by a 230-kV line from the coal-fired Colorado Ute power station near Hayden, Colorado.

Waters of the Eagle River watershed available to DWB would be diverted where possible by gravity and the remainder could be diverted near Wolcott by the pumping plant. The Eagle River pumping plant would operate during the months of May through July. These waters would be stored in Wolcott Reservoir and pumped during nine months of the year through the Wolcott-Dillon Tunnel. The pumping and gravity diversions from the Eagle River would be fully integrated with the operation of the Blue River collection system and the Roberts Tunnel diversion, to optimize the water yield in the respective basins and to minimize pumping costs. The following tabulation shows the historic and future streamflows affected by the potential Eagle River collection system.

TABLE 8-12

STREAMFLOWS IN EAGLE RIVER COLLECTION SYSTEM

Stream	Quantity
Eagle River	
Miles affected (below Eagle River River Diversion Works)	23
Historic flows Average (1964-1973)	561 cfs
Future flows Average	465 cfs
Eagle River tributaries	
Miles affected	29.1
Accumulative historic flows Average	47 cfs
Accumulative future flows Average	3 cfs

The average water yield from the Upper Eagle gravity system would amount to about 32,000 acre-feet per year. The remaining tributary water which would flow into the Eagle River, to be diverted by the Wolcott Diversion Dam and pumping plant into Wolcott Reservoir, would provide an average annual water supply of approximately 35,000 acre-feet. Thus, a net total of approximately 66,000 acre-feet of water would be obtained from this potential collection system, which does not include the 10,000 acre-foot yield from Straight Creek Diversion.

The normal water surface drawdown in Wolcott Reservoir would be about 25 feet a year, dropping from a high elevation of 7,330 in mid-summer to a low of 7,305 in late winter. The normal water surface area would vary from 1,505 to 1,350 acres on a seasonal basis. Although the reservoir would have about three years of holdover storage capacity (125,000 acre-feet), to protect against prolonged dry periods, extreme drawdowns could be expected.

Moffat System (William Fork River Area). The expanded Williams Fork Collection System would consist of a dam and reservoir on the South Fork of the Williams Fork River (South Fork Dam) to collect upstream runoff from the basin, a gravity tunnel and a closed gravity conduit to convey the stored South Fork water to a pumping plant which would be located near the Williams Fork River, and a pressure conduit to transport South Fork water to a closed gravity conduit. This gravity conduit would convey the South Fork water to the existing collection system (Gumlick Tunnel) as well as collect runoff from eleven small tributaries of the north slope of the Williams Fork River Basin.

These tributaries are located between Darling Creek and McQueary Creek. The water obtained from the South Fork and the eleven tributaries would be added to that of the existing Williams Fork Collection System. New appurtenant facilities would include access roads and power lines.

The axis for the South Fork Dam site would be 1.6 miles upstream from the mouth of the South Fork of the Williams Fork River. The elevation of the streambed at the dam axis is approximately 9,045 feet. The total capacity of the reservoir would be 13,000 acre-feet. The area inundated by the reservoir would be 160 acres. The potential dam would be about 195 feet high with a crest length of 1,700 feet.

A diversion tunnel would bypass the stream during construction of the dam and later be incorporated as part of the reservoir's emergency spillway. Embankment material for the dam could be obtained from borrow areas located downstream.

The tunnel and closed conduit from the reservoir to the pumping plant would operate by gravity and would be approximately 1.5 miles long.

The pumping plant site is in a flat area on the north bank of the Williams Fork River 0.2 mile downstream from its confluence with the Middle Fork, approximately 400 feet from the river. The elevation at the site is approximately 9,050 feet.

The pressure discharge line from the pumping plant to the gravity conduit would be made of steel pipe 0.8 mile long. Most of the pipe would be buried, although some of the pipe would be elevated on concrete piers. An energy dissipating structure would be required where the

discharge line joins the gravity conduit. The proposed location for this structure is alongside the existing North Fork road.

The north slope gravity conduit would extend from a tributary of Darling Creek to McQueary Creek, a distance of about 10 miles. The conduit would carry water under open-channel flow conditions. The existing conduit from the Gumlick Tunnel inlet to McQueary Creek, a distance of 1.5 miles, would be removed and replaced with a larger diameter pipe. The north slope gravity system would also require new diversion structures for those streamflows being collected between McQueary Creek and Darling Creek tributaries. Backfill material for construction of the conduit could be obtained from borrow sites along the existing North Fork road. Improvements in the existing North Fork road would also be necessary.

New access roads required would include approximately 1 mile reach of gravel road 20 feet wide from the existing Sugarloaf Campground road to the pumping plant and approximately 4.5 miles of gravel road 16 feet wide switching back and forth across the pressure discharge line from the pumping plant to the gravity conduit.

Electrical power transmission facilities would include a new single-pole line 1.8 miles long from the existing substation near the west portal of the Henderson Tunnel to the pumping plant and a single-pole line 2 miles long from the same substation to the South Fork Dam. For the most part, the power lines would be constructed next to access roads in the area.

The operation of the expanded William Fork collection system would be consistent with Colorado water law and other legal agreements, the need for additional water in Denver, and the capacity of the DWB's system to transport and store the water.

Runoff forecasting and other water resource management techniques would be used to determine the need for additional Williams Fork water. If it is determined that runoff from other sources is adequate, little or no water would be pumped from the South Fork Reservoir. The amount and timing of water pumped from the South Fork Reservoir would also be dependent on the demand for raw water.

The dam and reservoir on the South Fork of the Williams Fork River, the collection of water from the eleven tributaries of the north slope of the Williams Fork River Basin, and the enlarged Gross Reservoir would develop a total of 46,000 acre-feet of water. The new storage and collection facilities would account for 28,400 acre-feet of this total.

Present Environment

Soils and Terrestrial Resources. The following description covers only the Eagle River area. The description of the exisiting environment in the Williams Fork River watershed provided under Concept A is also applicable to Concept C.

Soils of the mountain slopes in the Eagle River area are of varying depths and are derived primarily from gneiss, granite, and schist. Soil pH ranges from acidic in the more mountainous terrain to alkaline in the lower elevations of the Eagle River drainage basin. Where vegetation offers protection, natural erosion is limited.

Concept A includes a detailed description, based upon range site descriptions of the Soil Conservation Service, of the soil types that might be found at varying elevations within the area.

The primary vegetative types within the study are the: (1) spruce-fir forests, (2) lodgepole pine stands, (3) aspen groves, (4) high mountain forest riparian, (5) upper montane-subalpine dry meadows, (6) upper montane-subalpine wet meadows, (7) pinon-juniper complex, and (8) sagebrush flats. These biotic communities are distributed throughout the area in a complex mosaic. The boundaries between these ecosystems are not sharply defined, since they tend to blend with one another in zones of transition called ecotones.

The predominant plant species and associated terrestrial wildlife community characteristic of the first six vegetative types have been described for the Roberts Tunnel system as part of Concept A.

The dominant floral elements of the pinon-juniper complex are Utah juniper, pinon pine, and several species of rabbitbrush. This lower elevation (6,000 to 8,000 feet) vegetative type is winter forage for large numbers of deer and elk. The shrub understory is available to wildlife except under the most severe winter conditions.

Other common shrubs and ground cover within the pinon-juniper "pygmy forest" are scrub oaks, mountain mahogany, serviceberry, groundsel, fleabane, golden beard, yucca, and cholla cactus.

Among the small rodents occupying pinon-juniper habitat are ground squirrels, deer mice, and cliff chipmunks. Large mammals which typically inhabit the area include mule deer, mountain lions, and coyotes.

Birds considered to be characteristic of the pinon-juniper woodland include the pinon jay, common bushtit, blue-gray gnatcatcher, brown towhee, plains titmouse, and scaled quail.

The sagebrush vegetative type occurs on dry open valleys at lower elevations throughout the study area.

The sagebrush vegetation type occurs in dense stands along open valley flats at lower elevations in the study area. The dominant plant species, big sagebrush and rabbitbrush, are mixed with a variety of shrubs (e.g., bitterbrush, currants, mountain mahogany, juniper, serviceberry, winterfat, snowberry) and grasses (bluegrass, squirreltail, western and bluebunch wheatgrass, Idaho fescue, needlegrass). Broomweed is a common invader species of disturbed areas. This ecosystem provides excellent winter forage for mule deer, elk, and domestic livestock.

Other mammals characteristic of the sagebrush ecosystem that are commonly found in the study area are the white-taile jackrabbit, Richardson's ground squirrel, coyote, and a wide variety of mice and voles. Birds typically using sagebrush flats for nesting or feeding include the sage grouse, mourning dove, Brewer's sparrow, lark sparrow, green-tailed towhee, pinon jay, rock wren, common bushtit, western kingbird, gray flycatcher, Say's phoebe, nighthawk, red-tailed hawk, golden eagle, marsh hawk, sparrow hawk, turkey vulture, and great-horned owl.

Southern slopes at higher elevation (8,000 to 11,500 feet) in the area support dense spruce-fir forests. High stream valleys are predominantly open and vegetated with dry meadows and riparian stands of willow and bog birch. South-facing slopes support scattered stands of aspen and lodgepole pine.

Wider stream valleys of lower elevations (6,000 to 7,500 feet) terminate against gently rolling foothills dominated by sagebrush flats and pinon-juniper forests. The valley floors support a mixture of sagebrush, juniper, and a few pinon pines with sparse ground cover. The riparian ecosystem in these locations consists of dense willow thickets, an occasional cottonwood and blue spruce, and a mixed understory of forbs, sedges, and rushes. Often stream confluences are dominated by a wet meadow of grasses, cattails, and sedges.

Mule deer and elk utilize the spruce-fir forests and aspen stands extensively for cover. During the summer, big game utilize the meadow and riparian communities of the higher elevation (8,000 to 11,500 feet) as a source of food and water.

Aquatic Resources. The Eagle River and its tributaries support cold water fisheries, which include trout populations of variable size. Brown trout dominate in the mainstem and most tributaries, with brook trout also providing a fishable population in most streams (Woodward-Envicon 1973). Rainbow and cutthroat trout also occur in several streams but are not abundant. The puite sculpin (formerly the eagle sculpin) is also present in most streams (Woodward-Envicon 1973).

The benthic invertebrates in the Eagle River and most tributaries are dominated by mayflies, with stoneflies second in relative abundance (Woodward-Envicon 1973). Immediately downstream from the Pando Dam, caddisflies are co-dominant with the mayflies.

The aquatic life of the Fraser and Williams Fork Rivers and Dillon Reservoir were previously discussed under Concept A. The aquatic systems of the east slope streams and reservoirs were also described under Concept A.

Under Concept C, additional water would be diverted from the Eagle River. The water quality of the Eagle River at the Wolcott Dam site, with the exception of Alkali Creek, is excellent. Alkali Creek, as befits its name, carries a somewhat greater salt load. The high salinity reflects the high concentration of sulfates in the drainage. At times, sulfates in Alkali Creek exceed the water quality standard for drinking water of 250 mg/l. Samples have been collected since 1972 by the DWB (DWB, undated). These show sulfate concentrations up to 400 mg/l. However, once this is mixed with the higher quality water from the Eagle River, dilution usually brings the sulfate concentration to within acceptable levels. Over the same period of record as Alkali Creek, the Eagle River immediately downstream from their confluence exceeded the 250 mg/l standard on one occasion with a concentration of 275 mg/l. No other water quality standards or criteria for raw water have been exceeded at other points in the Eagle River collection system.

The water quality of the Fraser, Williams Fork, and South Platte Rivers and Gross and Dillon Reservoirs was described under the discussion of Concept A.

<u>Important and Endangered Species</u>. Mule deer and elk are the most common big game species in the Eagle-Piney study area while black bear, mountain lion, and Bighorn sheep are also present. Eagle County is ranked among the top 10 counties in the State for both deer and elk harves (CDW 1974).

The pinon-juniper and sagebrush ecosystems in the study area are particularly important as mule deer winter range (Woodward-Envicon 1973). High deer pellet group counts in the vicinity of the potential Wolcott Dam and Reservoir have been recorded (Woodward-Envicon 1973). In addition, the Area Supervisor for the Colorado Division of Wildlife reported that a major east-west deer migration route existed at the Wolcott Reservoir site (Woodward-Envicon 1973). This portion of the study area is also a part of extensive elk winter range. The heavily browsed condition of the vegetation in the Wolcott Reservoir vicinity indicated that this range was fully stocked with elk (Woodward-Envicon 1973).

The most abundant small game mammal in the study area is the snowshoe hare. The Alkali Creek Valley in the study area supports a locally important sport hunting population of Nuttall's cottontails (Woodward-Envicon 1973).

The most common game bird in the study area, the blue grouse, accounted for more than 25 percent of the State's total harvest of this

species in 1974 (CDW 1974). The sage grouse is also common, and there are small populations of ptarmigan, mourning dove, and wild turkey.

According to a local ornithologist, the site of the potential Wolcott Reservoir lies along a heavily used bird migration route (Woodward-Envicon 1973). The most commonly observed species in this area are blue-winged teal and mallards. Additional sightings include the white-faced ibis, osprey, great blue heron, and bald eagle.

There are no known federally endangered mammals within the Eagle River area (CDW 1976). However, the historic ranges of three mammals, classified as endangered by the State of Colorado, overlap the Eagle watershed. They are the wolverine, Canadian lynx, and river otter. Portions of Eagle County are listed as areas of special interest for the wolverine (CDW 1976). Eagle County also contains habitat considered by the State to be essential to the Canadian lynx (CDW 1976). In addition, the State has plans to introduce river otters into the Eagle River drainage basin (personal communication, CDW, 1977).

The endangered peregrine falcon has been known to breed within the Eagle drainage basin. The State has identified portions of Eagle County along the Eagle River as essential habitat for the peregrine falcon (CDW 1976). Both the federally protected bald and golden eagle have been observed in the Eagle River watershed. A prior study indicated that both species may also breed within the Eagle study area (Woodward-Envicon, Inc. 1973). No other endangered bird species are known to exist in the study area.

Reference is made to Concept A for a discussion of the status of endangered plants, amphibians, and reptiles in Colorado.

<u>Recreation, Socio-Economic Conditions, and Cultural Resources</u>. The recreational, socio-economic, and cultural structure of the Williams Fork and Fraser River area (Moffat System) and the Dillon area (Roberts Tunnel System) is described in detail under Concept A. The additional coverage for Concept C will therefore concentrate on the Eagle River collection area.

Recreation and tourism are considered major industries within Eagle and Summit Counties. Major recreation resources include Dillon and Williams Fork Reservoirs, White River and Arapahoe National Forests, and the Gore Range-Eagles Nest Wilderness Area. There are six major ski areas within the Concept C area.

The area has recreation resources and facility needs for hiking, horseback riding, four-wheel vehicle driving, mountain climbing, picnicking, camping, boating (canoe and raft in streams and lakes), stream and lake fishing, hunting, cross-country skiing, and open snowmobiling. The streams are generally good for cold water fishing. The reservoirs are also good for fishing except for Williams Fork Reservoir, which is rated poor in the summer and fair in the fall. Hunting is described as good for big game.

The social and economic structure of the area in which the potential Eagle River water collection system would be located is based around mining, agriculture, construction, and recreation, but primarily the latter.

Located in Eagle County, the terrain is mountainous and conducive to winter sports and equally pleasurable summer activities. Responding to the demand of both tourists and Coloradoans, the town of Vail has mushroomed into a vital and progressive center of summer and winter recreational activity, impacting the economy, society, and population of the county. In 1970 there were about 7,100 people residing in Eagle County; the population is now estimated at about 12,000.

Mining, the second largest industry in the county, is giving way to tourism, which dominates the local economy. The Gilman mine is the largest source of mining production, and has assisted the economy of Minturn, Gilman, and Redcliff.

There is some agriculture to the west of Vail, and in the area of Wolcott and Edwards, and cattle graze in the meadows paralleling the Eagle River, but the stimulus of economic activity is at Vail. Here all ages congregate on the slopes of the surrounding mountains in the winter to ski. Hiking, fishing, photography, golfing, and other outdoor opportunities add to skiing, and those recreational activities make this county, with its proximity to a major east-west highway, and particularly the section influenced by the potential collection system, a delightful place to live.

Although the population of Vail is, to a great extent, transient, with many visitors using their condominiums on weekends, there are permanent residents to assure a stable community, which will continue to expand as long as the geographical confines of the mountains permit.

The results of the previous cultural resource investigations in the area of the Williams Fork System (CH_2M Hill 1976) were described under Concept A; those results apply to this concept also. The only difference is the magnitude of the areas which could be involved under the two plans. Under Concept A, the Williams Fork System would alter streamflows. Under Concept C, there would be a number of structural additions. Concept C would require more survey work for archeological sites prior to construction than Concept A and may ultimately require more mitigation.

The Eagle River system has had little survey work done for archeological and historical cultural resources. The only mention of such resources is in Woodward-Envicon 1972. In their inventory of natural, scenic, and historic areas, they mention twelve historic sites of varying degrees of interest, and indicate that no archeological sites have been encountered. However, there is ethnographic evidence that Utes used the area for hunting in historic times (Henderson 1926).

By inference and limited evidence, the types of cultural resources available in the above two components of Concept C would be very similar to those encountered in the upper areas of the potential Two Forks Reservoir. There are no sites in either of the Concept C areas that are on the National Register of Historic Places. As with the other concepts, it is very difficult to estimate quantity and/or quality of resources for the components of Concept C without more intensive survey work in each area. In either case, further survey work is necessary to establish a better base for information on cultural resources for this concept.

Analysis

Environmental Impacts

The impacts covered here (Concept C) are those involving potential construction and operation of the water collection system on the Eagle River and expansion of the Williams Fork Collection System.

General. The following discussion relates to temporary construction impacts only. Long-term impacts follow under appropriate headings.

Construction and enlargement of the above water collection systems would result in temporary, localized deterioration of air, noise, and water quality. Increases in noise and dust levels would be disturbing to recreationists and permanent residents. Increases in dust, hydrocarbons, nitrogen oxide, and carbon monoxide would result from the operation of heavy construction machinery.

Temporary unavoidable soil erosion from borrow areas and contractor haul spills could increase stream turbidity, which would reduce the quality of fishing as well as other water sport activities.

Following construction, borrow and waste disposal areas would be backfilled, shaped, and reseeded to blend with the natural surroundings.

The construction of the 37 mile tunnel (Wolcott-Dillon) passing under the Eagles Nest Wilderness Area would have no anticipated impact on the wilderness quality or experience of area visitors. All construction staging and access would be outside the wilderness area boundary, as would the disposal of excavated materials. Since the tunnel through the wilderness area would be from about 80 to 235 feet below the natural ground surface, no anticipated impact to wildlife from blasting should occur. Construction of a new access road for tunnel construction would cause temporary disruption to recreationists and displacement of wildlife.

Construction activity at South Fork and Wolcott Dams would also interfere with the quality of recreation experience. These activities would cut off accessibility to remote areas, forcing recreation users to drive around the construction site and to compete with construction vehicles for the use of narrow mountain roads and limited parking. New trails would need to be established for hikers, backpackers, and hunters.

The construction of the South Fork Dam would occur in a remote area and would be incongruent with the wilderness character of that area. Noise and dust associated with construction in this area would also degrade the quality of the recreation experience.

The impacts on the socio-economic structure of the communities involved in and near the construction sites would be similar to those of Concepts A and B. Businesses would be temporarily improved through the insurgence of the working forces, but the limited civic facilities of smaller communities could be taxed. This situation would be temporary, and the impact would terminate with the completion of construction.

Terrestrial Resources. The Eagle River diversion dam and pumping plant would be located near the confluence of Alkali Creek and the Eagle River, at an elevation of approximately 6,920 feet. The riparian habitat along Alkali Creek and the Eagle River in this area is of excellent quality, including many large Colorado blue spruce (Woodward-Envicon 1973).

Approximately 40 acres would be required for construction of the diversion dam and pumping plant. Construction activities would disrupt terrestrial vegetation and displace wildlife. Primary wildlife species affected would include those which make extensive use of riparian vegetation.

Due to the high quality of existing habitat and limited adjacent similar habitat, some displaced wildlife could have difficulty relocating and perish. Following construction, the value of the disturbed habitat could be restored through re-contouring and seeding with native vegetation. However, complete natural restoration of the riparian habitat would require hundreds of years.

Wolcott Dam and Reservoir would be constructed on Alkali Creek about 1 mile upstream from its confluence with the Eagle River. Surface area at the top of the conservation pool (elevation 7,330 feet) would be 1,505 acres. An additional 1,055 acres of right-of-way would be required for dam and reservoir construction.

The primary vegetative type inundated would be the sagebrush flats, including scattered junipers and pinon pines, of the wide valley floor. Also, some upland areas supporting both sagebrush flats and pinon-juniper forests would be flooded. The riparian habitat along Alkali Creek that would be lost consists primarily of dense willow thickets with a mixed forb understory.

At least 1,500 acres of terrestrial vegetation would be permanently lost by reservoir operation. Terrestrial wildlife would be displaced both by this loss of habitat and construction activities. The project site is part of a major winter range for deer and elk, and also provides habitat which is important to the Nuttall's cottontail (Woodward-Envicon 1973).

The potential reservoir would inundate and require relocation of 5.5 miles of State Highway 131. Construction along a 150 foot (average) right-of-way would temporarily disturb sagebrush and pinon-juniper vegetative types and displace wildlife. Terrestrial vegetation within a 50 foot operation right-of-way would be permanently lost.

Removal of borrow materials for the potential dam would be from within the conservation pool and would have no additional impact on vegetation and associated wildlife. Re-contouring and seeding of construction areas could minimize the project's impact on terrestrial ecosystems.

The Wolcott-Dillon Tunnel would extend more than 32 miles in an easterly direction, transporting water from the Eagle River pumping plant, under the White River National Forest and Gore Mountain Range, and into the Tenmile Creek drainage just west of the town of Frisco.

Impacts to terrestrial ecosystems would occur at the west and east portals of the potential tunnel. Lodgepole pine stands dominate south-facing slopes, and spruce-fir forests cover north-facing slopes in the west portal area. Construction and waste disposal in the west portal area would involve approximately 40 acres.

Some wildlife would be displaced by construction activities and destruction of habitat. Big game only occasionally migrate through this area, while the porcupine, golden-mantled ground squirrel, and chickaree are the most common inhabitants (Woodward-Envicon 1973). If the portal is constructed within the lodgepole pine forests of the northern slopes the impact to terrestrial wildlife could be minimized.

Vegetation within the potential east portal construction area consists mainly of aspen groves mixed with stands of lodgepole. Abundance of riparian vegetation and the associated terrestrial wildlife community has been reduced by construction of Interstate 70 and development around the town of Frisco. The amount of big game activity in the area is limited (Woodward-Envicon 1973). Wildlife displaced by construction activity and habitat destruction should be able to successfully relocate.

Impacts to terrestrial ecosystems could be reduced by construction of the east portal and associate energy dissipators as close to Interstate 70 as possible. The Wolcott-Dillon Tunnel construction and discharges should not impact the Colorado Division of Highway-Division of Wildlife stream habitat improvement project along Tenmile Creek upstream from the potential construction site.

A portion of the Wolcott-Dillon Tunnel would be constructed underground within the boundaries of the Eagles Nest Wilderness Area. Nineteen miles from the potential Wolcott Reservoir, the tunnel would pass 235 feet below the wilderness area boundary, extend for 12.9 miles under the preserve's surface, and exit 80 feet below the east boundary, one-half mile from the east portal site. This construction would have limited impact on the terrestrial ecosystems of the Eagles Nest Wilderness Area.

All of the 850,000 cubic yards of material excavated from the Wolcott-Dillon Tunnel would be disposed of outside of the Eagles Nest Wilderness Area boundaries. The eastern portal disposal area would be on DWB land adjacent to Dillon Lake. Impacts of tunnel construction on terrestrial ecosystems could be reduced by re-contouring and seeding disturbed areas immediately after the completion of construction.

Construction and waste disposal impacts would also occur in the immediate area of the two tunnel adits (vertical shafts used for access during construction and in maintenance) required for the Wolcott-Dillon Tunnel. Impacts to terrestrial ecosystems would be similar to those in the west portal area. The impact area would involve about 80 acres.

The Ute Creek pumping plant would be constructed within a sagebrush flat near the east bank of Ute Creek. Total land required for plant construction would be 40 acres. Terrestrial vegetation would be temporarily disturbed by construction and destroyed by placement of permanent facilities.

Due to the abundance of similar habitat in the vicinity of the potential construction site, most displaced wildlife should be able to successfully relocate.

The Homestake-Dillon Tunnel would extend a length of more than 26 miles from the upper end of the Eagle River watershed to an intersection with the Wolcott-Dillon Tunnel, 150 feet below the surface of the Eagles Nest Wilderness Area, and 6.9 miles from the Wolcott-Dillon east portal.

Portal construction of the Homestake-Dillon Tunnel would disturb vegetation and displace terrestrial wildlife. The 460,000 cubic yards of material excavated during tunnel construction would impact about 80 acres entirely outside the boundaries of the Eagles Nest Wilderness Area. This impact area should be contoured and seeded with native vegetation.

As a result of the potential project, average annual streamflows in a 23-mile reach of the Eagle River would be reduced from 561 cfs to 465 cfs. Such a flow reduction should have no effects on the existing quality of riparian vegetation. However, annual flows of a collective 29 miles of Eagle River tributaries would be reduced by about 90 percent (i.e., 47 cfs to 3 cfs). Tennant (1975) has noted that flow reductions of this magnitude can result in reduction of abundance and diversity of plant species comprising the riparian habitat. Diminishing the quality of streamside vegetation would result in the displacement and possible loss of terrestrial wildlife.

The collection system for the Homestake-Dillon Tunnel would reduce the flow and degrade the riparian habitat along 1.2 miles of the East Fork of the Eagle River, 0.5 mile of the South Fork of the Eagle River, 0.9 mile of Wearyman Creek, 3.4 miles of Turkey Creek, 0.7 mile of Lime Creek, 3.1 miles of Black Gore Creek, and 1.7 miles of seven unnamed

tributaries to Homestake Creek, 10.2 miles of Homestake Creek, 0.4 mile of Piney Creek, 0.3 mile of Yoder Creek, and 0.6 mile of Resolution Creek.

Of these, the greatest impacts to riparian vegetation and associated wildlife communities would occur along Wearyman, Lime, and Turkey Creeks. The habitat along all three streams is similar: mainly spruce-fir forests, but liberally mixed with aspen groves, lodgepole pine stands, and sage-bursh and willow thickets. These three drainage areas have been described as excellent habitat for elk, blue grouse, and small raptors (i.e., Cooper's hawk, goshawk, sharp-shinned hawk) (Woodward-Envicon 1973). Due to the high quality of this streamside habitat and lack of adjacent similar habitat, streamflow depletions should result in the loss of terrestrial wildlife.

The collection system for the Wolcott-Dillon Tunnel would deplete flows in 3.8 miles of Red Sandstone Creek, and 2.9 miles of Middle Creek. Both of these streams support good quality riparian vegetation. Flow reductions of more than 90 percent would diminish the quality of this habitat and displace terrestrial wildlife.

Project development within the Eagle study area would also require the construction of 12 miles of new 20-foot-wide gravel roads, and 3 miles of new 115 kV transmission lines. Vegetation within a 100-foot-wide (average) construction right-of-way would be temporarily disturbed and wildlife would be displaced. As the exact nature and location of access road and transmission line construction has not been determined, specific impacts to terrestrial ecosystems cannot be discussed. However, impacts could be minimized by re-contouring and seeding construction areas to native vegetation.

The potential South Fork Reservoir would inundate 1 mile of high mountain (9,200 feet) forest riparian habitat along the South Fork of the Williams Fork River. Dam and reservoir construction would require a 300-acre right-of-way with 160 acres being flooded when the water level is at the top of the conservation pool. The primary upland vegetative type within the potential reservoir boundary should be spruce-fir forest.

Construction activity and inundation would displace terrestrial wildlife from portions of the steep walls of the north-south trending canyon and riparian habitat along the valley floor.

If partially occupied similar habitat is available within a reasonable migratory distance, most displaced animals could successfully relocate. The abundance of forestland and associated riparian habitat within the project area vicinity should facilitate wildlife relocation. Impacts to terrestrial ecosystems could be reduced by minimizing the destruction of existing vegetation during constructon and re-contouring and seeding disturbed land following construction. The spruce-fir climax forest is a floristically uniform and ecologically simple community; however, simplicity and uniformity in community structure do not imply simplicity of origin or that reestablishment would be fast or complete.

It has been estimated (Ives 1941) that a period of 300 years would be required to reestablish a spruce-fir climax community. The oldest canopy members of a spruce-fir forest may be in excess of 500 years (Oosting and Reed 1952).

Additional wildlife habitat would be temporarily disturbed by the removal of borrow materials downstream from the damsite. During construction of the dam, the streamflow would be bypassed through a diversion tunnel. This should minimize the degradation of downstream riparian habitat that could be associated with streamflow depletion during construction.

A closed gravity conduit would extend for 1.3 miles through spruce-fir forests as it crosses the west-and east-facing slopes and peak of Sugarloaf Mountain (10,000 feet), between the potential South Fork Reservoir and Williams Fork River pumping plant. The buried conduit would also cross the main Williams Fork River in an area bounded by forest riparian habitat. This potential action would disturb vegetation and displace associated wildlife. Displaced animals should be able to successfully relocate due to abundant similar habitat in adjacent uplands and stream valleys. Destruction of the spruce-fir climax along the 50-foot-wide construction right-of-way would have to be considered to be a long-term impact due to the time required (i.e., 300 years) for reestablishment of vegetation.

The Williams Fork River pumping plant would be constructed in relatively flat valley uplands (9,050 feet) abutted to the north by steep, south-facing slopes. Dominant vegetation should be a mixture of forest riparian and forest upland habitat, probably including a mixture of willows, bog birch, aspen, spruce-fir, and lodgepole pine.

Plant construction would disturb 5 acres of terrestrial vegetation and displace associated wildlife. Following construction, 4 acres of land could be partially reclaimed by re-contouring and seeding with native vegetation.

The conduit between the Williams Fork pumping plant and the Gumlick Tunnel would traverse 10.6 miles of primarily forest land with a few scattered patches of subalpine dry meadow. The first portion of this conduit (0.8 mile) would be pressurized, consisting of a combination of buried and elevated (on concrete piers) pipeline. The remainder (9.8 miles) would be open-channel, gravity conduit. According to the topographic map of the area (USGS, Ute Creek 15' Quadrangle, 1933), approximately 95 percent of the conduit corridor would be through subalpine (9,250 to 10,400 feet) forest. Seventy percent of the route would be along south-facing slopes with the remainder traversing a northeast trending ridge. Accordingly, the vegetation along the route should be predominantly spruce-fir forests liberally mixed with aspen groves and lodgepole pine stands.

The 50-foot-wide construction right-of-way would also cross eleven small tributaries of the Williams Fork River between Darling and McQueary Creeks. None of these streams are bordered by high mountain forest riparian habitat. One flows through primarily open wet meadows, and one (McQueary Creek) is adjacent to a mixture of these two vegetative types.

Construction of the conduit would disturb vegetation and displace associated wildlife. Due to the length of the potential conduit (i.e., 10.6 miles) and probable degree of vegetation clearing required, some of the displaced animals, failing at relocation attempts, could perish. Re-contouring and seeding could reduce the impacts to terrestrial ecosystems. In addition, the elevated portions of the 0.8 mile pressurized conduit could impact wildlife migration routes.

Borrow sites for conduit construction would be along the existing North Fork road; thus, the impact to terrestrial vegetation and wildlife should be minimized.

The existing 1.5-mile-long tunnel between McQueary Creek and the Gumlick Tunnel would be removed and replaced with larger diameter pipe. This should primarily impact the spruce-fir ecosystem along the 50-foot-wide construction right-of-way on the steep west-facing slope at an elevation of 10,400 feet. Some displaced wildlife could have difficulty relocating and perish.

Project development would entail construction of new access roads and power tranmission lines as well as improvement of the existing North Fork road which parallels the potential conduit corridor. A 1.8-mile single-pole transmission line would be constructed between the existing Henderson substation and the Williams Fork pumping plant site. This activity would disturb 11 acres of high mountain forest and willow-birch riparian ecosystems. In addition, the proposed route would cross the upper reach of the main Williams Fork River. Construction activity would displace wildlife and could result in the loss of some animals. Another single-pole transmission line, requiring 12 acres of construction right-of-way, would traverse the 2 mile distance between the Henderson substation and the South Fork damsite. This route would cross the South Fork of the Williams Fork River, disturbing primarily the high mountain forest flood plain and riparian vegetative communities. Again, wildlife would be displaced and could perish if unable to relocate in adjacent habitat. Portions of both of these transmission lines would parallel existing access road corridors, thus reducing the impact on terrestrial ecosystems.

One mile of new 20-foot-wide gravel access road would be constructed between the existing Sugarloaf Campground and the Williams Fork pumping plant. This route would loop the tranmission line corridor, thus minimizing impacts to terrestrial ecosystems.

Another 4.6 miles of new access road would be constructed between the Williams Fork pumping plant and the potential open-channel gravity conduit.

While this route would ascend the area planned for construction of the 0.8 mile of closed pressure conduit, impact to the predominant spruce-fir, aspen, and lodgpole pine forestland would be magnified. Due to the steep, south-facing slope, the 16-foot-wide gravel road would have to be constructed using severe switchbacks across the conduit corridor. This would result in the disruption of an additional 27 acres of terrestrial vegetation and commensurate displacement of wildlife.

Approximately 10 miles of the existing North Fork access road would have to be improved in order to construct and service the open-channel gravity conduit. This activity would take place entirely within the potential conduit construction corridor and thus not have any impacts on terrestrial ecosystems beyond those previously discussed for the conduit.

Small diversion structures would be constructed on eleven tributaries of the Williams Fork River at elevations of 10,400 to 10,600 feet. Collectively, the average annual flow in these streams would be reduced by more than 90 percent. According to Tennant (1975) such flow reductions would degrade the quality of riparian habitat along these streams downstream from the diversion points to the confluence with the Williams Fork River. Streamside vegetation in this area should be primarily mixed stands of Englemann spruce, subalpine fir, aspen, and lodgepole pine, with thickets of willow and bog birch directly adjacent to and within the stream channel. Reduction of the quantity of riparian habitat along 6 miles of babbling mountain brooks would also displace wildlife. Due to the relatively large drainage area affected by these streamflow depletions, some displaced animals, having difficulty relocating, could perish.

Aquatic Resources. Annual depletion of the Eagle River and its tributaries would be quite variable, ranging from about 20 percent on the Eagle River to about 90 percent on the tributary streams. Depletions in the area of 20 percent during the peak runoff period would not lead to any significant impacts on either the fishery or supporting populations of aquatic organisms. However, depletions of 90 percent would significantly reduce the available aquatic habitat and the standing crop of aquatic organisms and total stream productivity. However, the smaller streams have been relatively unproductive under current conditions due to steep gradients and small size (Woodward-Envicon 1973). Sampling indicated that no fish or extremely low populations were present in several streams (Woodward-Envicon 1973).

The dams, for both diversion and storage, would affect the existing aquatic communities. Dams in general block the upstream migration of fish. This can result in an effective loss of spawning habitat, although this would not be significant if there is sufficient habitat downstream from the dam. However, several of the streams that support populations of brook and/or cutthroat trout are so small and shallow that they may freeze to the bottom under the right circumstances, eliminating the fish. The diversion dams in such a case would block repopulation from larger downstream areas.

The storage reservoir on the South Fork of the Williams Fork would bring about a change in the aquatic community. For example, stoneflies supply the second highest biomass of invertebrates currently. Impoundment would essentially eliminate the stoneflies from the river reach since they are adapted to a running water habitat. The sculpin would be similarly eliminated. There would be an increase in caddisflies and trueflies, as well as aquatic earthworms, which are more adpated to slow-moving or standing waters. The river reach where the reservoir would be impounded supports a good standing crop of brook trout and provides heavily used spawning habitat (CH_2M Hill 1976); the latter would be eliminated. Impoundment would also decrease the maximum summer temperatures and provide colder water to the downstream river reach; this could further alter the stream ecology below the dam. On the other hand, sampling on Alkali Creek indicated no fish. Impoundment and additional diversion from the Eagle River would provide a fishery where little or none presently exists (Woodward-Envicon 1973).

Concept C provides for no east slope storage, other than the enlargement of Gross Reservoir. The enlargement of Gross Reservoir was discussed under Concepts A and B. Other impacts would be similar in magnitude to those of the Foothills Project at the 125 mgd level, except that the remaining reach of the North Fork would have to be stabilized. This would result in extensive degradation of the remaining habitat.

The water quality standard of 250 mg/l of sulfate for waters for domestic use has been exceeded on occasion in the lower Eagle River. However, other waters diverted through Roberts Tunnel are relatively low in sulfates and would be available for dilution. As a result, no additional treatment costs would be incurred for the removal of excessive soluble salts such as sulfates. All other chemical species quantities are within acceptable limits, and standard treatment only would be required prior to distribution.

Under Concept C, an annual average of 268,000 acre-feet of relatively high-quality water would be diverted from the upper Colorado River drainage to the Denver metropolitan area for municipal and industrial use. This diverted water would be considerably lower in salinity than that downstream and would be unavailable for dilution. An annual average of 41,000 tons of dissolved solids would also be diverted to the east slope. However, as was the case in Concepts A and B, an increase in downstream salinity concentrations in the Colorado River could be expected. As outlined, development of Concept C, using the same criteria as for Concept A, would result in an approximate increase in salinity concentrations in the Colorado River at Cameo, Colorado of 38 mg/l, and 24 mg/l at Imperial Dam, Arizona.

An increase in municipal and industrial water would increase the volume of effluent from the Denver metropolitan sewage systems. Through the proposed effluent exchange program, there would be less diluting water and a great quantity of sewage effluent in the South Platte River. Under

this concept, the exchange program would provide an addition 72,000 acre-feet per year of raw water in exchange for a like amount of effluent to be diverted downstream. This would result in higher levels of biological oxygen demand, dissolved solids, and any industrial chemicals not removed in the treatment process at least as far downstream as the final diversion point. However, there would be less degradation than would occur under the previous two concepts because of the greater amount of diluting water available.

Disposal of material excavated from the Wolcott-Dillon Tunnel on DWB land around the edge of Dillon Reservoir could impact waterfowl nesting and feeding habitat as well as brown and rainbow trout spawning and migration habitat. The disposal plan in this area would require close controls to assure placement of waste material above the maximum water surface elevation of Dillon Reservoir and above the bottom flood plain land of Tenmile Creek.

Important and Endangered Species. Because the Eagle River watershed supports some of the best elk and mule deer habitat in Colorado, the potential development would impact both of these species. During construction, total harvest of these big game species as well as other small game (e.g., snowshoe hare, blue grouse) species within the study area should decrease. In addition, the populations of beaver, muskrat, and mink in the Eagle River drainage area should be reduced by the potential development.

Golden and bald eagles could suffer loss of nesting and hunting habitat as a result of deterioration of riparian habitat within the area. If this happens, the distribution of these raptor species within the Eagle River watershed would be affected.

The peregrine falcon's use of and distribution within the area also could be impacted by streamflow depletions and inundation of riparian habitat.

Construction activity and loss of habitat could impact the historic range of the Canadian lynx, wolverine, and river otter. Since the status of these three species within the study area is unknown, specific impacts to their habitat and abundance cannot be discussed.

The Williams Fork River watershed supports some of the best elk and mule deer habitat in the State. Accordingly, total harvest of these big game species could be reduced by project development. The harvest of small game (e.g., snowshoe hare, blue grouse) could also be reduced. Similarly, destruction of riparian habitat could reduce furbearer populations, particularly beaver, muskrat, and mink, within the Williams Fork study area.

Hunting and nesting habitat of bald and golden eagles and the peregrine falcon within the Williams Fork study area could be reduced by project development, particularly destruction or degradation of the quality of riparian habitat.

Since the status of populations of Canadian lynx, wolverine, and river otter in the study area are not specifically known, impacts cannot be adequately addressed. However, project development could impact the historic ranges of these three species.

The discussion provided in Concept A regarding the status of endangered plants, amphibians, and reptiles in Colorado is applicable to Concept C.

Recreation, Socio-Economic, and Cultural. Expansion of the Williams Fork Collection System would deplete flows of the tributaries between Darling and McQueary Creeks; however, these creeks have no identifiable fisheries. Fishing opportunities would be reduced commensurate with the reduction in flows.

The overall reduction in flows and the installation of power lines, the access road, and water conduits would detract from the aesthetic experience and reduce the quality of recreation for horseback riders, picnickers, hikers, and backpackers. However, the access road would provide greater back country accessibility for hunters.

South Fork Dam would provide a 160-surface-acre reservoir on the South Fork of the Williams Fork River. However, the dam and reservoir could essentially eliminate the trout fishery on this tributary, which is one of the better tributaries of the Williams Fork (Kelley 1976). It is anticipated the South Fork Reservoir water would be similar in quality to that of the nearby Williams Fork Reservoir, i.e., "poor in summer and fair in fall" (Kelley 1976). The reason is reservoir fluctuation; stocking requirements would not be as great as in the more accessible reservoirs, and there would be little natural production. The reservoir would provide only shore fishing opportunities, some picnicking, and some camping.

Adverse impacts would also include a reduction in the availability of quality fishing streams in the area. Flows in the Williams Fork River would be reduced, and any migration of fish would be hindered by the structure. Therefore, fishing would be more concentrated in a smaller area rather than spread out, as it presently is.

The Eagle River presently provides a diversity of recreation opportunities including minimal floating opportunities for canoes and rafts. Floating usually occurs during the spring and early summer runoff when there is sufficient water. The diversion of 67,000 acre-feet from the upper and lower Eagle River system could eliminate some seasonal river floating.

Eagle River depletion should not affect the excellent quality of fishing in the river, which is heavily stocked with rainbow and brown trout. The river flows could not fluctuate as much and conceivably could improve spring fishing.

Wolcott Dam and Reservoir on Alkali Creek would store up to 135,000 acre-feet and provide up to 1,505 surface acres for recreation. The recreation potential for the reservoir is good. However, a continuous nine-month drawdown beginning in July would curtail late summer, fall, and winter uses. The reservoir could provide a cold water fishery, which would help meet the needs for lake fishing in the area. Associated activities that could be developed include camping, picnicking, water skiing, and ice fishing. Concessionaires could conceivably rent boats for fishing, water skiing, and boating because the reservoir would be filling or near full during the peak recreation season.

Impacts of the construction of the Straight Creek facilities, disposal of tunnel muck, and enlargement of Gross Dam would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

The construction of South Fork and Wolcott Dams and Reservoirs would not require relocation of real property or people.

Since both the South Fork and Wolcott Reservoirs would experience seasonal drawdowns, adverse impacts to the overall scenic quality of those areas could be expected during winter months. No long-term visual or aesthetic impacts to the Eagles Nest Wilderness Area would occur.

With completion of Wolcott Dam and Reservoir, the town of Wolcott and the immediate vicinity would experience a significant increase in tourist visitation. More service-related establishments would be built in and near Wolcott. Land speculators and developers would move in and acquire land adjacent to Wolcott Dam and Reservoir right-of-way lands. Zoning would be needed to control a haphazard proliferation of cabins, homes, and trailers. Sanitation problems could also arise.

The material excavated from the Wolcott-Dillon Tunnel would be disposed of on the edge of Dillon Reservoir (east portal disposal area). This disposal would create a new day-use area with potential recreational benefits. Visual and aesthetic values could be maintained by trimming and blending disposal materials with lands around the lake.

In terms of long-range energy impacts the 117 million kwh of energy annually required to pump Eagle River water into Dillon Lake would deplete coal reserves by about 59,000 tons a year.

The historic and prehistoric sites, if any, would be investigated were this concept to be activated, and appropriate measures, as described in the other concepts, would be undertaken to preserve or salvage these resources. As in portions of the other components, the beneficial effects of systematic mitigatory research would probably outweigh the adverse impacts on the archeologic resource base. The most negative effect would come from destruction of historic structures.

CHAPTER 9

CONSULTATION AND COORDINATION

HISTORY OF COORDINATION EFFORTS

The Director of the Bureau of Land Management assigned the Colorado State Director of BLM lead responsibility for preparation of the initial draft environmental statement (DES) for the proposed Foothills Project in October 1974. The Bureau instituted coordination with the following Federal agencies at that time:

The U.S. Forest Service, to use their draft analysis of environmental impacts relating to the proposed action;

The U.S. Fish and Wildlife Service, to consult with and act as an active member of the team for wildlife concerns;

The Bureau of Outdoor Recreation, to consult on the recreational and aesthetic effects of the proposed project; and

The Bureau of Reclamation for hydrologic expertise and assistance.

The team, led by BLM, represented broad categories of environmental concern, including socio-economics, hydrology, geology, soils, fisheries, climate, air quality, plants, animals, engineering, cultural resources, recreation, and aesthetics. The draft was filed with the Council on Environmental Quality (CEQ) December 1975, and issued in January 1976. Public hearings were conducted February 19, 1976.

July 8, 1976, the Regional Solicitor ruled that the scope of this DES was insufficient as a matter of law, and recommended that the Secretary of the Interior postpone his decision on the proposed Foothills project pending comprehensive analysis.

In response, the Office of the Secretary of the Interior on preparation and planning requested a new preparation plan which was initiated by the Colorado State Director of the BLM. This plan was approved by the BLM Washington Office on February 8, 1977. A new (DES) team was formed in early February 1977. An inter-agency Federal team was established as the core team; participation of each agency is detailed in the section following. In addition, an advisory group of 60 organization, public agencies, and private individuals provided assistance and expertise in their particular interest areas; a list of the Advisory Group follows in the Consultation section. A brochure, which described the purpose of the revised draft and invited public participation, was widely circulated in February 1977, when the team began work.

CONSULTATION AND COORDINATION IN PREPARATION OF THE DES

Consultation in preparing the second DES was sought in three forms. Federal agencies were contacted; State and municipal agencies and interest groups were consulted; comments received on the original (February 1976) DES were reviewed.

Table 9-1 lists the Federal agencies contacted through formal consultation and coordination procedures and the type and extent of their assistance.

Federal Agencies Contacted

TABLE 9-1

FEDERAL AGENCY ASSISTANCE

Agency	Nature of Contact	Type & Extent of Assistance
U.S. Forest Service	Requested staff and data assistance, and preliminary review	Provided one core team member for Forestry-Flora sections; provided Recreation and other data; provided team advisor and continual review
Bureau of Reclamation	Requested staff and data assistance; requested sole effort through the Department of the Interior for Raw Water Source Alternatives, and preliminary review	Provided one core team member for Hydrology sections; provided 16 team advisors to solely produce Concepts A, B, and C of Alternate Raw Water Sources (Chapter 8); provided continual review
U.S. Fish & Wildlife Service (FWS)	Requested staff and data assistance; consultation with FWS concerning any modification of wildlife resources under Sec. 662 of Wildlife Coordination Act (see Official report Appendix 4)	Provided one core team member for Fish and Wildlife section; provided consultation and official report in compliance with FWS Coordination Act, Sec. 662; provided continual review
U.S. Bureau of Outdoor Recreation	Requested staff and data assistance	Provided one core team member for Recreation section; provided Recreation/Aesthetics and other relevant data

TABLE 9-1 (Cont.)

FEDERAL AGENCY ASSISTANCE

Agency	Nature of Contact	Type & Extent of Assistance
U.S. Army Corps of Engineers	Requested data assistance and preliminary review	Provided data assistance and review of preliminary draft in advance of printing
Federal Power Commission	Requested data assistance and preliminary review	Provided data assistance and review of preliminary draft in advance of printing
U.S. Geological Survey	Requested consultation with team and assistance in special areas of Geology, Minerals, and Topography	Provided consultation and assistance
Soil Conservation Service	Requested consultation with team and assistance in special areas	Provided consultation and assistance with soil surveys
Environmental Protection Agency	Requested data assistance and advisory help	Provided data assistance and team advisor
Department of Housing and Urban Development	Requested data assistance and advisory help	Provided data assistance and team advisor

State Agencies, Municipal Agencies, and Interest Groups Contacted

A special effort was made to expand the consultation effort outside of the core team, using 60 advisors from the State of Colorado, from local municipal agencies, and from special interest groups and private individuals. Some advisors contributed as members of various sub-work groups; others expressed their concerns in occasional advisory meetings.

Sub-work Groups

Sub-work groups were formed on the basis of environmental components chaired by the core team members. A list of participants follows:

Archaeology/History Sub-Work Group

State Historical Society of Colorado (SHPO): Michael Quinn, James Hartman
Advisory Council on Historic Preservation: Lewis Wall, Brit Storey
Colorado State Archeologist
Northern Colorado Educational Board of Cooperative Services, Longmont, Colo.
Park County Historical Society
University of Colorado, Henderson Museum
University of Denver

Socio-Economics Sub-Work Group

State of Colorado Division of Planning
Denver Regional Council of Governments
Environmental Protection Agency
Office of Housing and Urban Development

Water Resources Sub-Work Group

Denver Regional Council of Governments
Colorado Board of Health: Water Quality Control Division
Colorado State Engineer
Colorado Water Conservation Board

Recreation/Aesthetics Sub-Work Group

Colorado Division of Parks and Outdoor Recreation
U.S. Forest Service

Geology-Minerals Sub-Work Group

U.S. Geological Survey
Colorado Geological Survey
Consulting geologists (2)

Fish and Wildlife Sub-Work Group

Colorado Division of Wildlife (DWO)
Rocky Mountain Bighorn Sheep Society
Trout Unlimited

Land Use Sub-Work Group

Colorado Land Use Commission

Air Quality Sub-Work Group

Colorado Board of Health: Air Pollution Control Division

Other Team Advisors

In addition to the sub-work groups, other interested municipal agencies and interest groups communicated their interests and concerns during various advisory meetings, and informal oral communications. These advisors included:

Adams County Commissioners
City of Aurora
City of Broomfield
Boulder County Planning Department
Citizens for Sensible Water
Colorado State University Plant Information Center
City of Denver
Environmental Defense Fund
City of Lakewood
City of Longmont
Pikes Peak Council of Governments
Platte Canyon Water Association
Rio Grande Company
South Platte Canyon Preservation Council
City of Thornton
City of Wheatridge

Comments on Original Draft Environmental Statement

Comments were received on the original (February 1976) DES in both public hearings and by letter.

Comments were received in the public hearings from the following:

Honorable William H. McNichols, Mayor of Denver
John R. Bermingham, private citizen
John A. Yelenick, President of the Denver Board of Water Commissioners
Stephen Hart, lawyer
Herbert C. Gundell, Denver County County Agent
James T. Smith, United Sportsman's Council
John Retrum, Zero Population Growth, Colorado
Jerry Mallett, Wilderness Resource Institute
Lewis Short, Manager, Lakewood Board of Sewer and Water Commissioners
Robert Weaver, Trout Unlimited
John L. J. Hart, Colorado State Advisory Board
Ken Coors, Denver Chamber of Commerce
Mills E. Bunker, Consulting Engineer
Mary C. Taylor, Colorado Open Space Council
Cynthia Emrick, State Historical Preservation Office
William Slaichert, private citizen

William M. Benight, Concerned Citizens for the Upper Platte River
David A. Curtis, Douglas County Commissioner
Mack D. Dahman, private citizen
William Green, Denver Regional Council of Governments
Alexander Kudalis, private citizen
Paul S. Sternick, Executive Secretary, Denver Metro Association of Plumbing, Heating, and Cooling Contractors
Ruth Steel, private citizen
Joane Patterson, Jefferson County Commissioner
Kay Collins, Denver Audubon Society
Kim Wickholm, Sierra Club
Edward P. Connors, private citizen
Thomas Hornsby Ferrill, Editor, Littleton Independent
Earl Perry, Colorado Whitewater Association
Deane Hall, American Canoe Assn.
Randy Waesche, private citizen
James Sato, Water Resources Engineer
D. A. Rainey, Colorado Historical Society
Hans W. von Barby, Rocky Mountain Bighorn Sheep Society
J. Robert Doyle, Environmental Protection Agency
Merle Jornod, private citizen

Comments were received by letter from the following:

Mrs. James Lane, private citizen
The U.S. Army Corps of Engineers, Omaha
Richard Kithil, private citizen
The Advisory Council on Historic Preservation
U.S. Soil Conservation Service
Colorado State Historical Society
Patti Penland, private citizen
Sierra Club Legal Defense Fund
Bureau of Outdoor Recreation
Margaret Wright, private citizen
Richard Kuehster, private citizen
Eight citizens of the Denver Area
Tim Crislor, private citizen
Roger Brown, private citizen
Twin Cedar Lodge
Metro Denver Water Study Commission
Federal Highway Administration
James Holland, private citizen
Greeley Audubon Society
Marilyn Sherman, private citizen
Martin Bates, private citizen
Frank and Jean Richardson, private citizens
Department of Health, Education, and Welfare
Caroline Hildt, private citizen
Protect Our Mountain Environment
Mr. and Mrs. Carl Santi, private citizens
William Hamilton, private citizen
Mr. and Mrs. Remple, private citizens
Douglas County Commissioners
City of Aurora
U.S. Department of Commerce
Mr. and Mrs. Gillings, private citizens
Carroll Newberry, private citizen
Colorado Environmental Health Assn.
Environmental Protection Agency
Swayback Ranch
Denver Regional Council of Governments
League of Women Voters
Barbara Barto, private citizen
James Ogilvie, Denver Water Board
Jack Parsons, Denver Water Board
Fish and Wildlife Service, Salt Lake City, Utah
Martin Fowler, private citizen
Greeley Commission on the Environment
Mills Bunger, private citizen
Pikes Peak Fly Fishers
Kim Wickholm, Sierra Club
John Hart, private citizen
Merle Jornod, private citizen
Enos Mills Branch of the Sierra Club
Environmental Defense Fund
Mary Cox, private citizen
Public Service Company
Carmello Condino, private citizen

Colorado Land Use Commissions	Missouri River Basin Commission
June Wilmore, private citizen	Jefferson County Planning Office
U.S. Bureau of Mines	Colorado Division of Planning
Colorado Department of Wildlife	Colorado Geological Survey
U.S. Forest Service	Colorado Department of Highways
Colorado River Water Conservation District	Colorado Department of Health
	Colorado Water Conservation Board
Trout Unlimited	Douglas Planning Office
Denver Audubon Society	Kathleen A. Judson, private citizen

Many concerns were raised in these letters and comments, such as the consensus that the DES was inadequate in scope, did not deal with the necessity of planning for new raw water sources to operate the proposed Foothills project, did not sufficiently assess the impact of the proposed treatment plant on the Rocky Mountain Bighorn Sheep in Waterton Canyon, and many others. The DES addresses all of these concerns, both for the Foothills plant's initial 125 MGD capacity and its proposed 500 MGD maximum capacity and the resultant impacts. The public will have further opportunity to voice opinions and concerns regarding this draft at public hearings and by direct mail after this draft is printed.

COORDINATION IN THE REVIEW OF THE DRAFT ENVIRONMENTAL STATEMENT

Comments on the DES will be requested from the following Federal agencies, State Clearinghouses, and interest groups:

Advisory Council on Historic Preservation

Department of Agriculture
- Forest Service
- Soil Conservation

Department of Commerce

Department of Defense
- Corps of Engineers

Environmental Protection Agency

Federal Power Commission

Department of Health, Education & Welfare

Department of Housing and Urban Development

Department of the Interior
- U.S. Fish & Wildlife Service
- U.S. Geological Survey
- Bureau of Mines
- National Park Service
- Bureau of Reclamation
- Bureau of Outdoor Recreation

River Basin Commission
- Arkansas River
- Upper Colorado River
- Missouri River

Department of Transportation

Water Resources Council

State Clearinghouses
- State of Arizona
- State of California
- State of Colorado
- State of Utah

Under the Colorado Clearinghouse system, comments will be requested from:

- State Historical Society of Colorado
- Colorado Division of Wildlife
- Colorado Department of Health: Water Quality Division, Air Pollution Control Division
- Colorado Division of Water Resources
- Colorado Division of Parks and Outdoor Recreation
- Colorado Land Use Commission
- Colorado Department of Natural Resources
- Colorado Division of Planning

Comments will be requested from members of the team advisory groups, listed in the preceding section of this chapter, and additional special interest groups such as: the historical societies of Jefferson County, Douglas County, and Park County, the Colorado Open Space Council, the Institute of Ecology, the League of Women Voters, the National Resources Defense Council, and the Sierra Club.

Public hearings will be held during the 30-45 day period after the Council of Environmental Quality posts official notice of the issuance of this draft environmental statement in the Federal Register, around July 29, 1977.

Copies of this draft environmental statement will be available for public inspection at the locations listed below:

Bureau of Land Management:

Washington Office of Public Affairs
18th and C Streets
Washington, D.C. 20240 Phone: (202) 343-4151

Colorado State Public Affairs Office
Room 700, Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202 Phone: (303) 837-4481

Canon City District Office
3080 East Main Street
Canon City, Colorado 81212 Phone : (303) 275-7494

Northeast Resource Area Office
1010-10th Street
Golden, Colorado 80401 Phone: (303) 234-4988

Public Libraries:

Denver Public Library
1357 Broadway, Denver, Colorado 80202

Adams County Library System
10530 Huron, Northglenn, Colorado 80234

Arapahoe County Library System
6840 S. University Blvd., Littleton, Colorado 80122

Colorado State Library
1362 Lincoln, Denver, Colorado 80202

Douglas County Library System
303 Gilbert, Castle Rock, Colorado 80104

Jefferson County Library System
10200 West 20th Avenue, Lakewood, Colorado 80211

Bailey Library
Bailey, Colorado 80421

Aurora Library
1297 Peoria, Aurora, Colorado 80011

Boulder Library
1000 Canyon Blvd., Boulder, Colorado 80302

Broomfield Library
Garden Office Center, Broomfield, Colorado 80020

Englewood Library
3400 South Elati, Englewood, Colorado 80110

Littleton Library
6014 South Datura, Littleton, Colorado 80120

Thornton Library
2211 Eppinger Blvd., Thornton, Colorado 80229

Westminster Library
3031 W. 76th Ave., Westminster, Colorado 80030

County Office Buildings:

Adams County
450 South 4th Avenue, Brighton, Colorado 80601

Arapahoe County
2069 West Littleton Boulevard, Littleton, Colorado 80120

Boulder County
P. O. Box 471, Boulder, Colorado 80302

Clear Creek County
P. O. Box 547, Georgetown, Colorado 80444

Denver County
Room 451, City and County Building, Denver, Colorado 80202

Douglas County
300 Wilcox, Castle Rock, Colorado 80104

Eagle County
55 Broadway, Eagle, Colorado 81631

Gilpin County
P. O. Box 366, Central City, Colorado 80427

Jefferson County
1700 Arapahoe, Golden, Colorado 80149

Park County
P. O. Box 128, Fairplay, Colorado 80440

Summit County
P. O. Box 1538, Breckenridge, Colorado 80424

Teller County
P. O. Box 248, Cripple Creek, Colorado 80813

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APPENDICES

APPENDIX 1.

Foothills Ecology Project:
The Bighorn Sheep of the South Platte

By

Richard E. Jones and Christine C. Jones

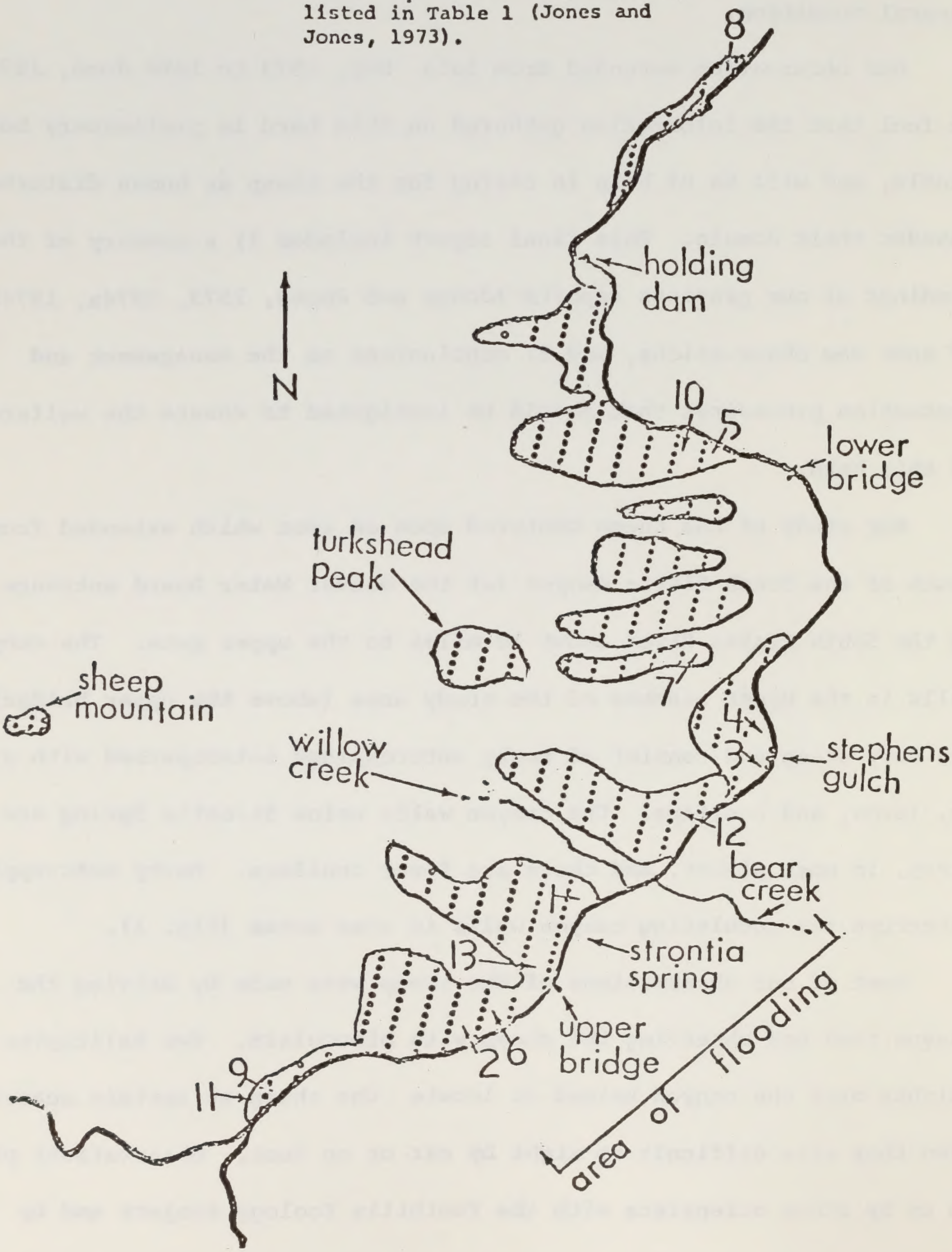
In late May, 1973, we were assigned the task of investigating a herd of Bighorn Sheep in the South Platte Canyon, Colorado. Proposed construction of the Turkshead and Two Forks dams in this canyon produced an urgent need for information on the number of sheep in the canyon and their population structure, home range, food habits, habitat usage and general condition.

Our observation extended from late May, 1973 to late June, 1974. We feel that the information gathered on this herd is preliminary but reliable, and will be of help in caring for the sheep as human disturbance invades their domain. This final report includes 1) a summary of the findings of our previous reports (Jones and Jones, 1973, 1974a, 1974b), 2) some new observations, and 3) conclusions on the management and protection procedures that should be instigated to ensure the welfare of this herd.

Our study of the sheep centered upon an area which extended from the mouth of the South Platte canyon (at the Denver Water Board entrance gate) up the South Platte River about 10 miles to the upper gate. The canyon walls in the upper reaches of the study area (above the upper bridge) are very steep and consist of rocky outcroppings interspersed with grasses, forbs, and conifers. The canyon walls below Strontia Spring are less steep, in most places, and there are fewer conifers. Rocky outcroppings interrupt the undulating canyon walls in some areas (Fig. 1).

Most of our observations of the sheep were made by driving the canyon road and observing the sheep with binoculars. Two helicopter flights over the canyon helped us locate the sheep at certain seasons when they were difficult to sight by car or on foot. Observations passed to us by other scientists with the Foothills Ecology Project and by

Figure 1. [illegible]
Hatched regions indicate steep, rocky topography. Numbers refer to localities of sheep sightings listed in Table 1 (Jones and Jones, 1973).



Denver Water Board Personnel were of great help.

II. Sheep usage of canyon

A. Summer

Observations in the summer of 1973 and 1974 indicate that the sheep use the upper reaches of the canyon, immediately below the lower bridge to the upper gate, at this time of the year. Most of the sheep prefer the NW and W side of the river, frequenting the steep, rocky slopes extending to the water's edge. They seem to avoid stands of conifers. Older rams remains separate from the ewes, yearlings and lambs at this time of the year.

B. Winter

In the fall, the sheep move down the canyon to areas I-IV described in Fig. 2. These areas make up the major wintering ground of this herd. They consist of steep, rocky, ridges extending to the river. These ridges alternate with steep, brushy canyons. The herd, now consisting of all sexes and ages, remains on this wintering ground during breeding activities.

C. Spring

In late March, the older rams move up the canyon and the pregnant ewes retreat to a high rocky ridge above the lower bridge and near Turkshead Peak. Fortunately, this area is not susceptible to human disturbance.

D. Usage of the E and SE canyon walls

As mentioned, most of the sheep were observed on the NW and W side of the canyon. Only rarely did we see sheep on the E or SE canyon walls. In the winter, one small mixed group was observed near the small holding dam, 1.8 miles up the canyon from the lower gate (see Fig. 2). In late summer, 4 ewes were seen on the SE side of the canyon near the upper

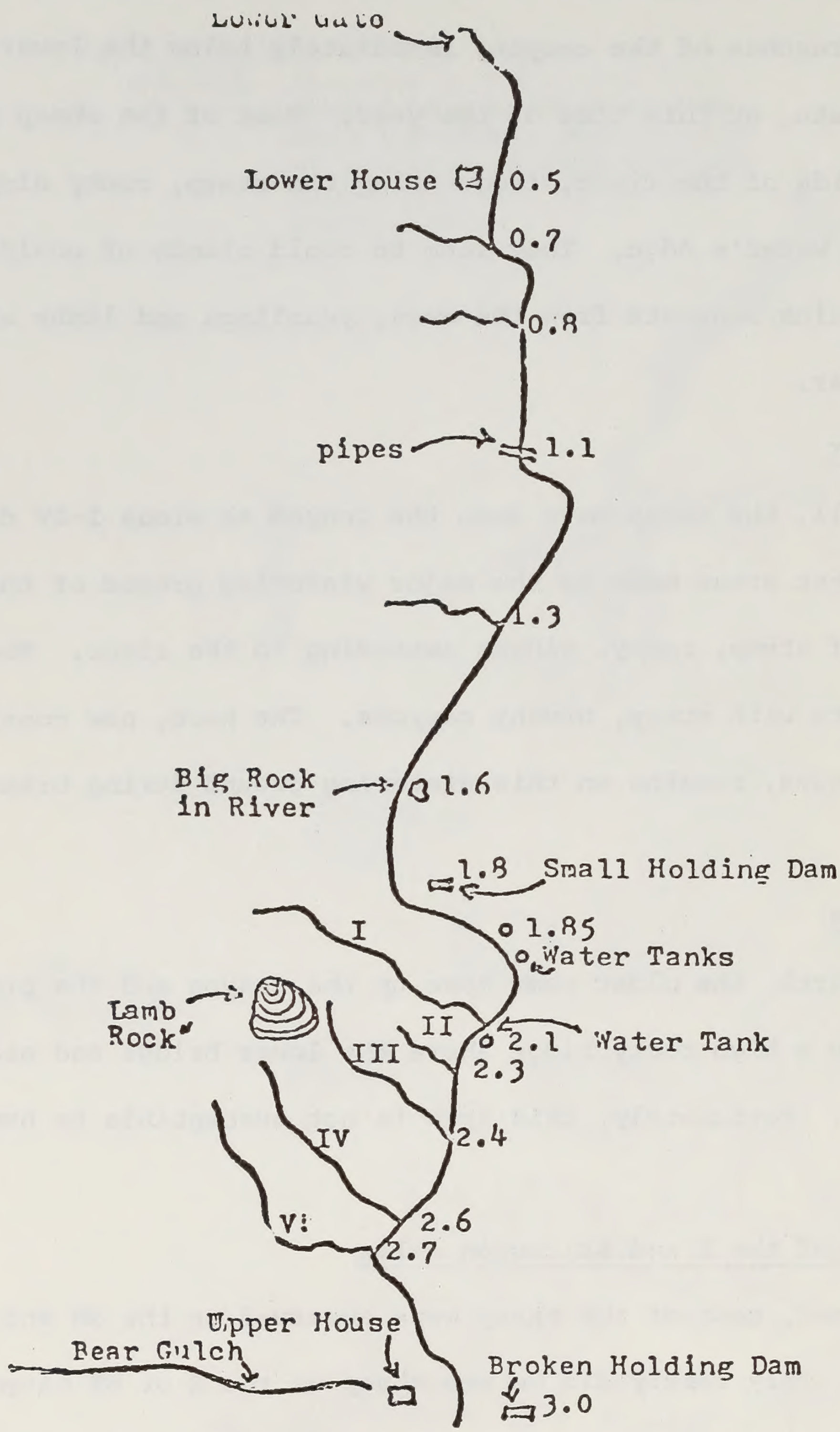


Fig. 2. Rough map of wintering area. Numbers refer to miles from lower gate. Roman numerals refer to gulches that descend from "Lamb Rock" to road. Major sheep wintering area is in gulches III and IV and their intervening rocky ridges.

bridge. It is difficult to determine if 1) these sheep crossed the river and are part of the South Platte Canyon herd, or 2) they wandered into the canyon from the herd located to the south near Roxborough Park. At any rate, very few sheep use the E and SE canyon walls, probably because of less sun exposure and fewer rocky outcroppings.

III. Herd Population Size and Structure

Moser (1962) counted 13 rams and 36 females, lambs and yearlings in Nov., 1955 in the South Platte Canyon. In 1962, he estimated this herd at 50 animals. Charles Hector (Cited by Bear and Jones, 1973) estimated the canyon herd to number about 18. Therefore, a drastic reduction in herd size occurred between 1962 and 1970. Discussions with residents of the area indicate that this loss of sheep was mainly due to poaching by workers building the lower holding dam. Since 1970, the herd, through lamb recruitment and protection against hunting, has increased rapidly to our estimate of 35 sheep in 1973 and 1974.

On March 3, 1974, we observed a mixed group of 27 sheep, including 4 lambs, 2 yearling females, 7 ewes, 1 yearling male, 5 2-3 yr males, 4 3-6 yr males, and 4 5-8 yr males with no males over 8 yr being present. The absence of old rams probably reflects the aforementioned illegal poaching in the 1960's. These data suggest a present ram:ewe ration of about 185:100, and a lamb:ewe ration of about 57:100. The latter ratio indicates that about 1/2 of the lambs born suffered post-natal mortality. However, observation of ewes in May, 1974, indicate that only about 4 ewes were pregnant (out of about 15 ewes total). Therefore, disturbance of breeding activity may have effected pregnancy rate. Of these 4 ewes, only 2 gave birth to surviving lambs, as indicated by our second helicopter survey. In general, we feel that the herd is growing at a rate of about 1-3 sheep per year, assuming a dominance of natality over mortality.

IV. Disease problems

In 1958, Pillmore (1959) examined lungs of 6 sheep from this canyon and found that all contained lungworm infection. We have found lungworm larvae in most feces samples collected, and also have observed symptoms of lungworm infection (coughing, rough coat) in 2 ewes in the herd. Transmission of lungworm is most prevalent in a crowded situation, and we feel that overcrowding of the sheep on the small wintering ground is a potential if not overt health hazard to the sheep.

V. Food habits and habitat impact

The sheep in the canyon graze on grasses and forbs and browse on shrub species (see our 1973 report for identification of plants utilized). Food availability is not a problem on the summer range, but the small wintering area exhibits heavy impact from sheep usage. We believe that the herd is at maximum size in relation to the carrying capacity of this winter range.

VI. Competition from other species

Competition from other ungulates does not seem severe. Domestic cattle and sheep do not graze in the canyon. Elk occur in the area from October to April, and deer are present all year (Bear and Jones, 1973). We observed several deer competing with sheep for browse on the wintering ground, and this competition may have a slight negative effect on sheep welfare at this time.

VII. Hunting

According to Bear and Jones (1973), the South Platte herd was hunted for 13 consecutive years, from 1954-1966. Out of 92 liscenses issued, 43 rams were killed, indicating a very high hunting success of 47%. This high success was almost certainly due to the accessibility and tameness of this herd. Apparently, legal hunting was stopped in 1967 because of

the drastic reduction in herd size due to illegal hunting.

We understand that at least one bow-hunting permit has been issued for the 1974 season, so it appears that hunting of this herd at a low level is present Game and Fish policy. We consider this a healthy policy, because we believe that the herd should not be allowed to increase above its present number. However, we also believe that, along with legal hunting of only one sheep a year, all means of enforcement should be employed to prevent poaching, especially by workers on the proposed dams.

VIII. Predation

Some of the post-natal mortality of lambs is almost certainly due to coyote predation. Coyotes are numerous in the canyon. Also, the few mountain lions in the canyon may take a few sheep. However, we feel that predation is a natural limiting factor, and one that should be maintained. In 1974, the Game and Fish Department hired a trapper to remove some potential predators on the sheep (e.g., coyotes, bobcats). Apparently, (hearsay) this was based on the observation that, although 5 lambs were present in the summer of 1973, only one was present in the winter of 1973. However, our careful search revealed that at least 4 of the 5 lambs survived their first winter.

IX. Human disturbance

We were impressed with the amount of harassment of the sheep by people during the winter. The sheep wintering-breeding ground is near the road, and readily accessible to hikers, photographers, etc. We are sure that the normal breeding activities were at least slightly disturbed by human intrusion. This sould be kept to a minimum. Legitimate scientists and photographers should be allowed access to the slopes of the canyon only by written permission. Other people interested in observing the sheep breeding behavior should be allowed to do so only from the road.

The activities of men and equipment during dam construction should be planned to 1) avoid disturbance of the sheep when breeding, and 2) avoid physical damage to the wintering area. Seasonal movements of the sheep should not be impeded by construction work. Other disturbance, such as harassment of the sheep by the many helicopters used in relation to dam construction, should be avoided.

X. General discussion and conclusions

The trend of Colorado Bighorn sheep populations is consistently downward. In 1915, there were 7,230 sheep in Colorado; whereas there were 3,200 in 1958 and 2,200 in 1970 (Bear and Jones, 1973). The South Platte Canyon herd offers some unique opportunities to study this endangered species. According to George D. Bear, sheep expert for the Colorado Game and Fish Department (letter of April 29, 1974) "This herd is indigenous to the area. I believe it was historically part of the Mt. Evans herd. As you might note, there has been little work done on the herd." The knowledge obtained from our study is the most thorough available, but more information is needed. For example, we must know if the range of the herd extends up the canyons of the north and south forks of the South Platte River. Also, the herd physical condition, size, sex and age structure, and movement patterns must be monitored during and after construction of the proposed dams. Only then can appropriate management adjustments be made to ensure survival of the sheep in this canyon.

The accessibility of this herd offers a unique opportunity for biologists to study in detail the ethology and ecology of this species, and offers the public a chance to observe at close range a remnant of our wild heritage. We feel strongly that public observation of these animals, without disturbing them, will be of great benefit. It is a poor soul

that is not increased in environmental awareness by the experience of contact with these animals.

APPENDIX 2.

Examples of a Stream Improvement Program

Joint report of the Colorado Division of Highways, the U.S. Forest Service, and the Colorado Division of Wildlife.

(Design by Colorado Division of Highways for Eagle River between Eagle and Gypsum. Required to accommodate a segment of Interstate 70. Structures were designed to develop pools and meander channel. Structures were designed to withstand wide variation in flows and would be suitable for the South Platte River below the South Platte Intake . . . DOW)

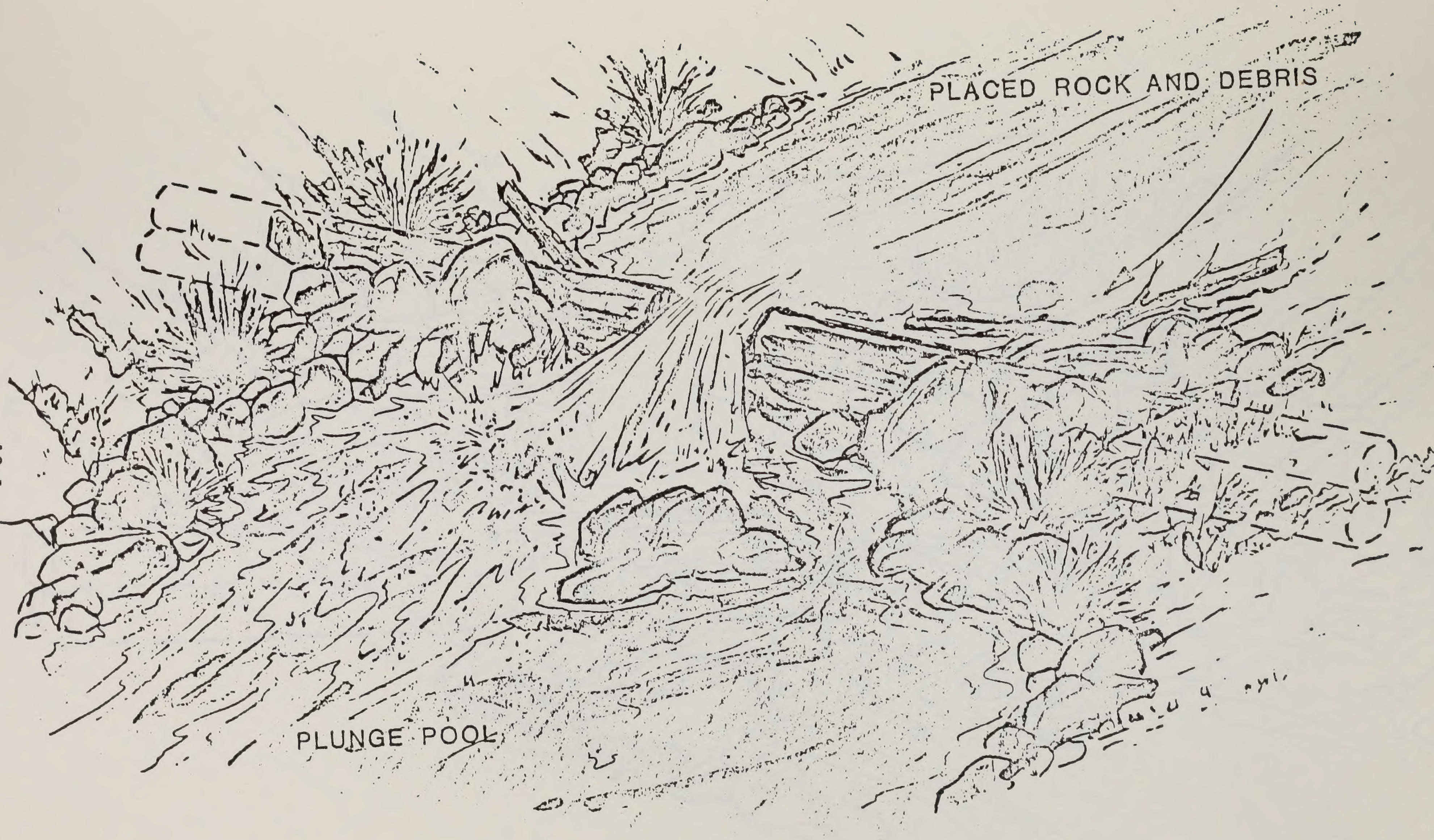
APPENDIX 2

Examples of [illegible] Stream Improvement Projects

Joint report of the Colorado Division of Highways, the U.S. Forest Service, and the Colorado Division of Wildlife.

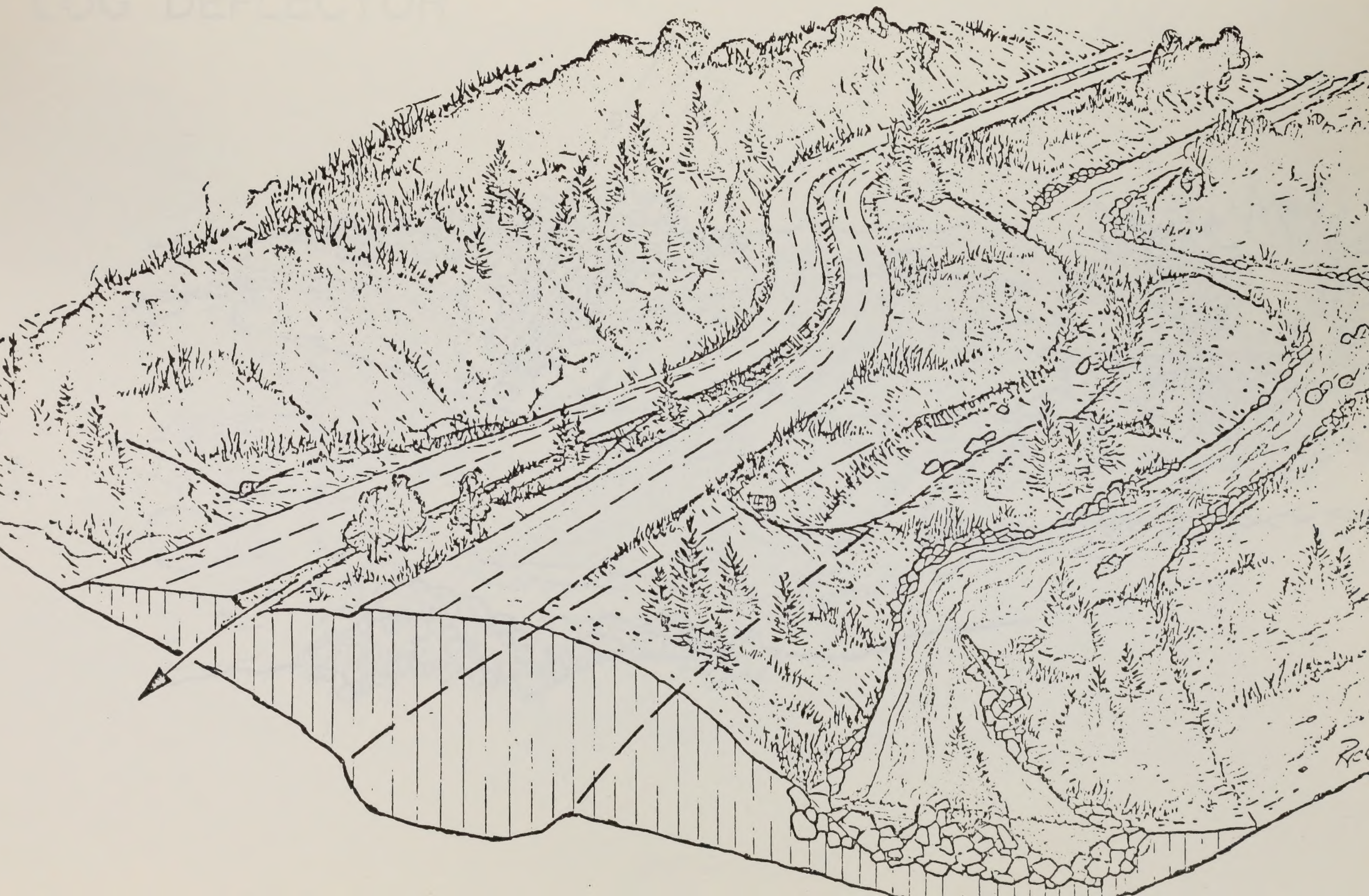
Umbrella by Colorado Division of Highways for Eagle River between Vail and Dowd. Required to accommodate a segment of Interstate 70. Structures were designed to maintain pools and meander channel. Structures were designed to withstand wide variation in flows and would be suitable for the South Platte River below the South Platte intake. [illegible] 1981)

LOG WEIR

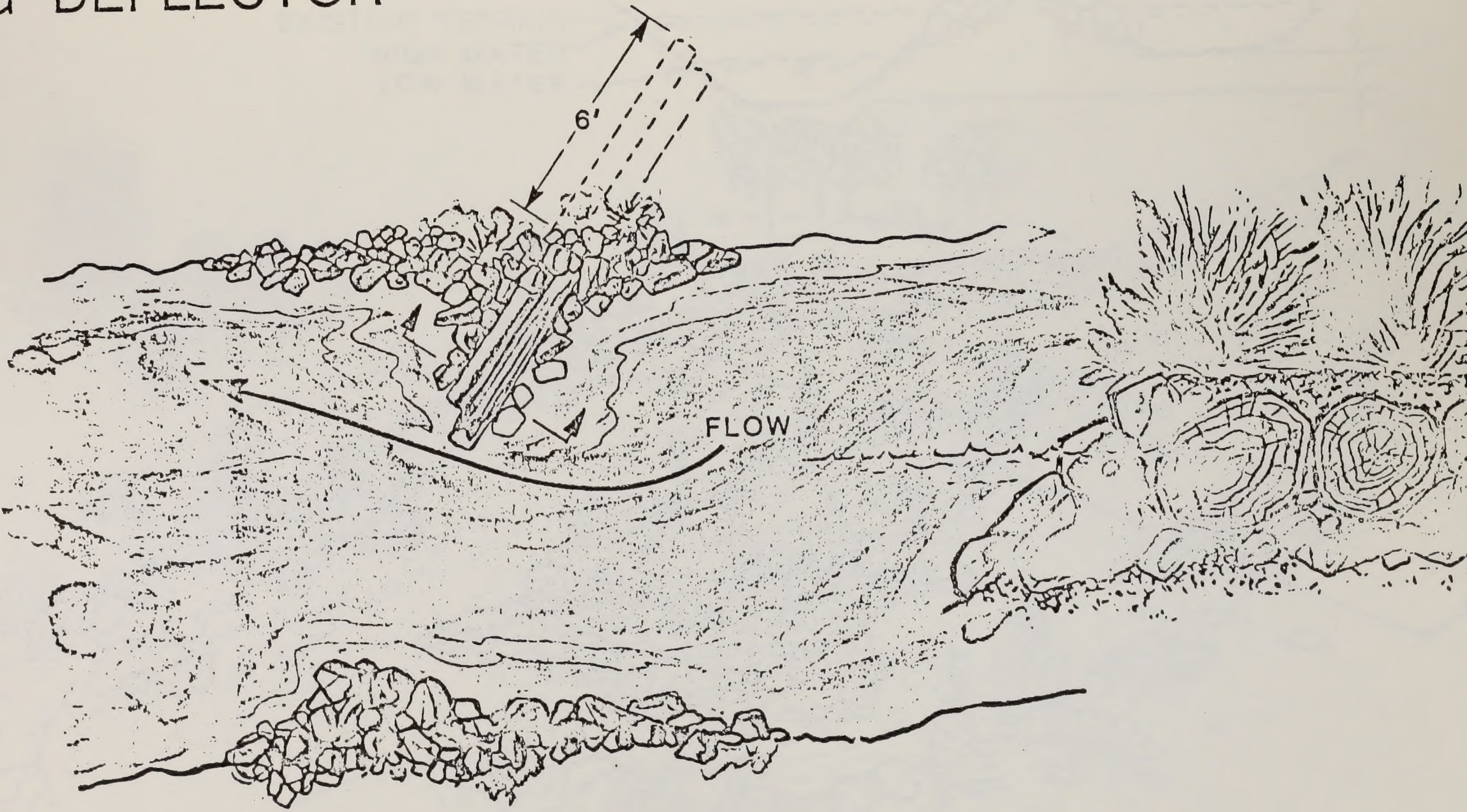


DEFLECTOR CONFIGURATION

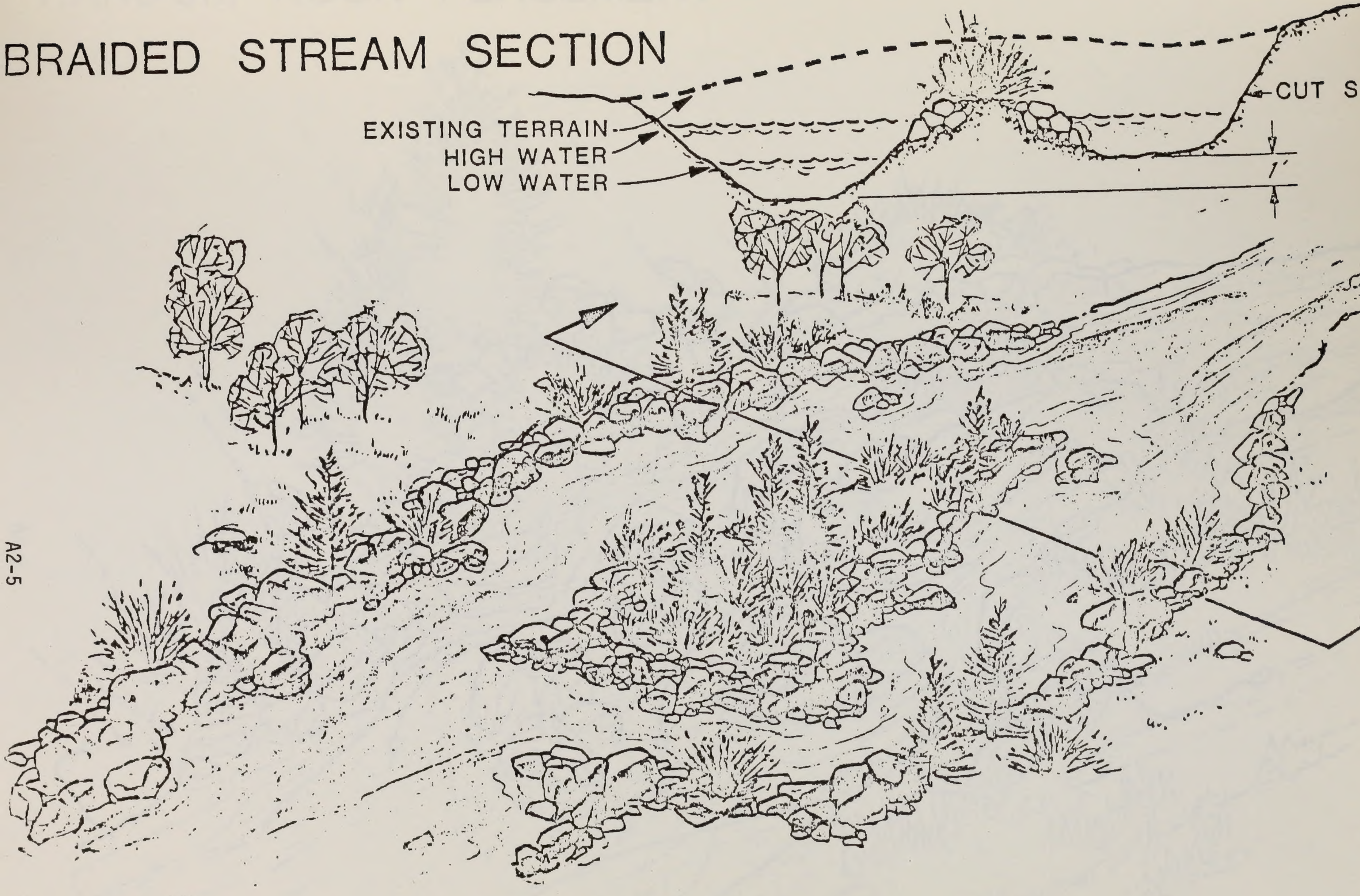
OVERALL CHANNEL CHANGE LANDSCAPE INTEGRATION



LOG DEFLECTOR



BRAIDED STREAM SECTION

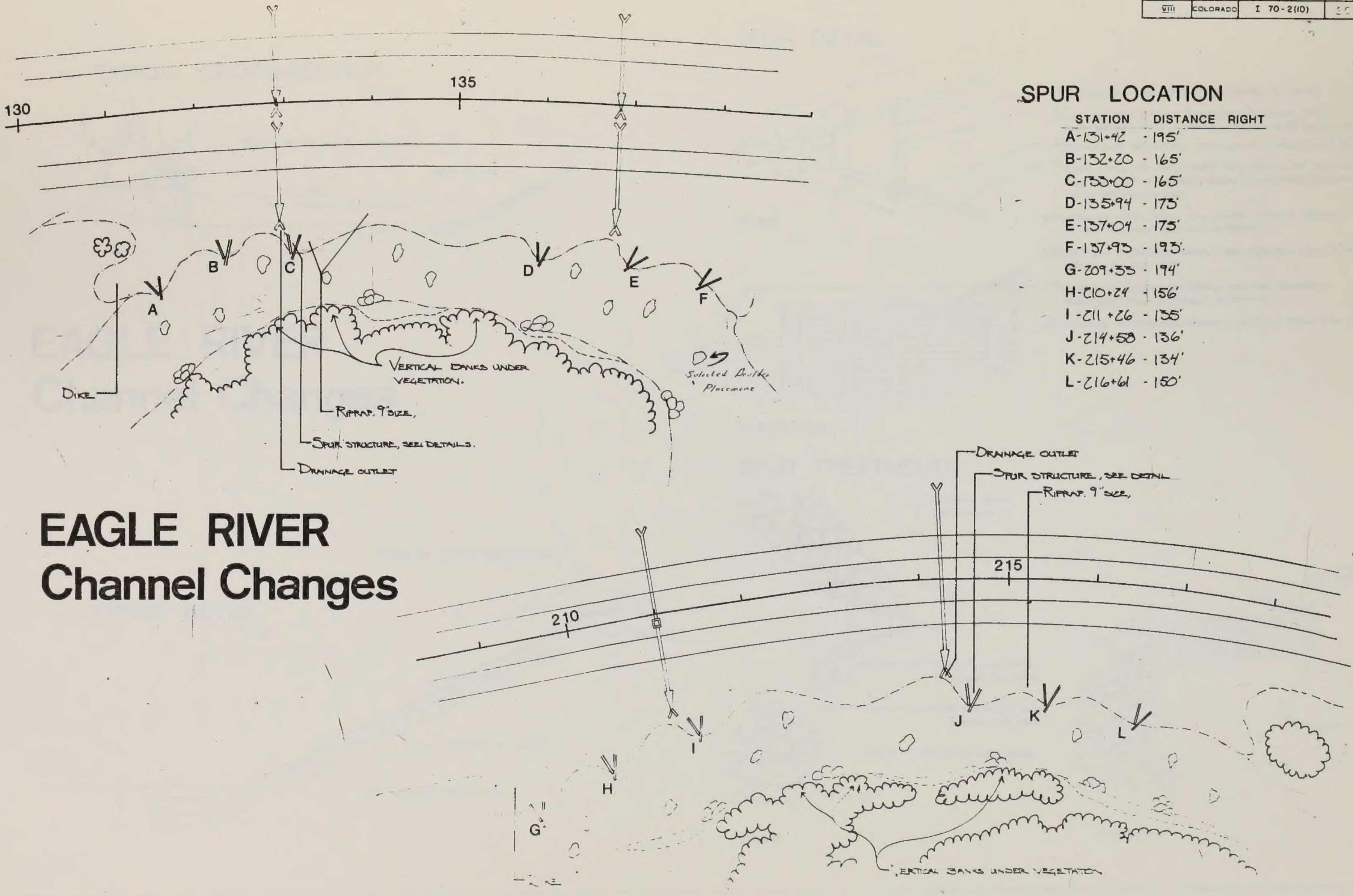


RANDOM ROCK PLACEMENT

FALLEN TREE DEFLECTOR

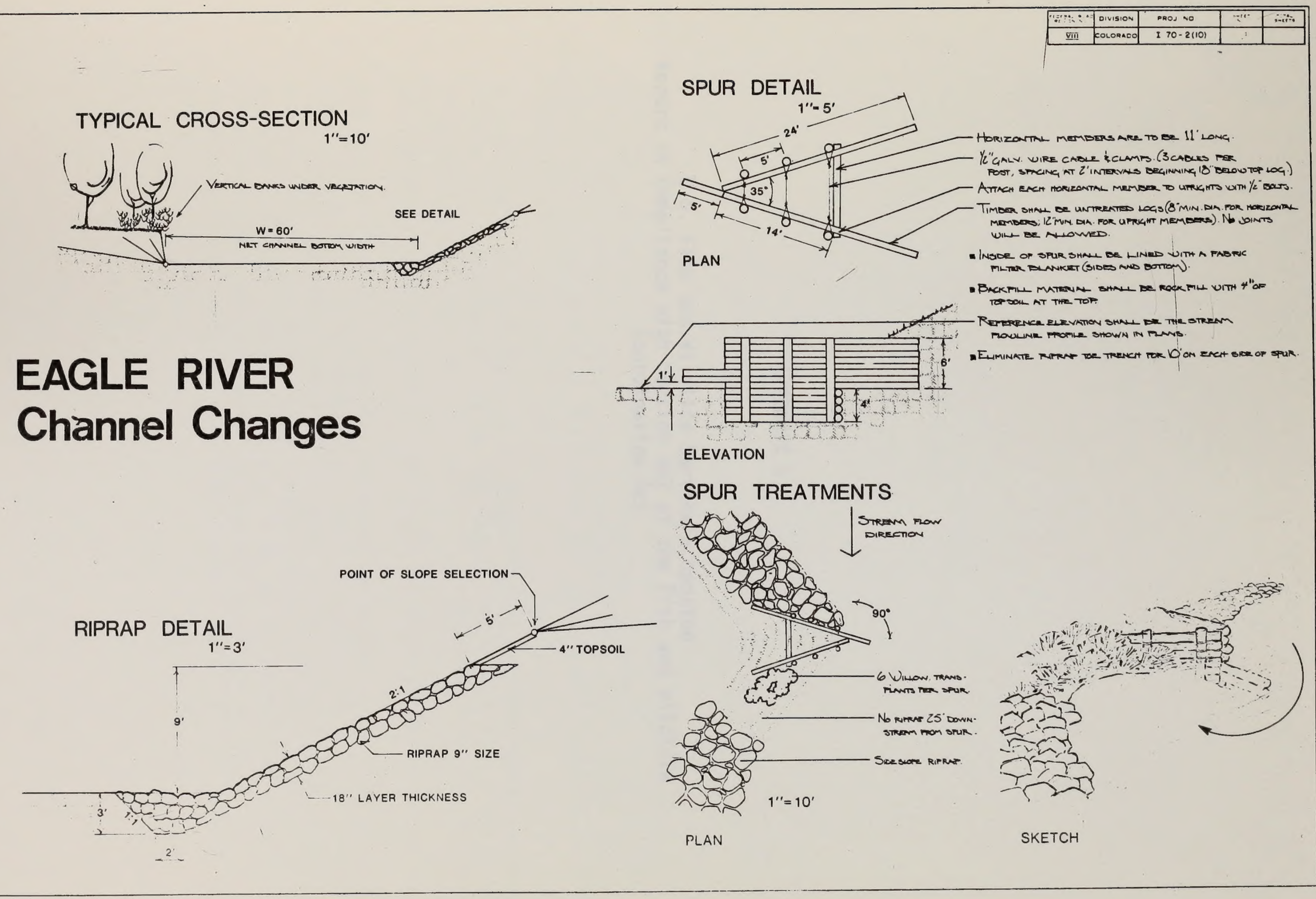
FEDERAL AID REGION	DIVISION	PROJ NO	SHEET NO	TOTAL SHEETS
VIII	COLORADO	I 70-2(10)		

EAGLE RIVER
Channel Changes



SPUR LOCATION

STATION	DISTANCE RIGHT
A-131+42	195'
B-132+20	165'
C-133+00	165'
D-135+94	175'
E-137+04	175'
F-137+93	193'
G-209+33	194'
H-210+24	156'
I-211+26	135'
J-214+58	136'
K-215+46	134'
L-216+61	150'



DIVISION
PROJ NO
VIII
COLORADO
I 70-2(10)
EAGLE RIVER
Channel Changes
TYPICAL CROSS-SECTION
1"=10'
VERTICAL BANKS UNDER VEGETATION.
SEE DETAIL
W=60'
NET CHANNEL BOTTOM WIDTH
SPUR DETAIL
1"=5'
24'
5'
35°
5'
14'
PLAN
HORIZONTAL MEMBERS ARE TO BE 11' LONG.
½" GALV. WIRE CABLE & CLAMPS. (3 CABLES PER POST, SPACING AT 2' INTERVALS BEGINNING 18" BELOW TOP LOG.)
ATTACH EACH HORIZONTAL MEMBER TO UPRIGHTS WITH ½" BOLTS.
TIMBER SHALL BE UNTREATED LOGS (8" MIN. DIA. FOR HORIZONTAL MEMBERS, 12" MIN. DIA. FOR UPRIGHT MEMBERS). NO JOINTS WILL BE ALLOWED.
INSIDE OF SPUR SHALL BE LINED WITH A FABRIC FILTER BLANKET (SIDES AND BOTTOM).
BACKFILL MATERIAL SHALL BE ROCK FILL WITH 4" OF TOPSOIL AT THE TOP.
REFERENCE ELEVATION SHALL BE THE STREAM FLOWLINE PROFILE SHOWN IN PLANS.
ELIMINATE RIPRAP TOE TRENCH FOR 10' ON EACH SIDE OF SPUR.
1'
6'
4'
ELEVATION
SPUR TREATMENTS
STREAM FLOW DIRECTION
90°
6 WILLOW TRANS-PLANTS PER SPUR.
NO RIPRAP 25' DOWN-STREAM FROM SPUR.
SIDE SLOPE RIPRAP.
1"=10'
PLAN
SKETCH
RIPRAP DETAIL
1"=3'
POINT OF SLOPE SELECTION
5'
4" TOPSOIL
2:1
9'
RIPRAP 9" SIZE
18" LAYER THICKNESS
3'
1:1
2'

APPENDIX 3.

U.S. Fish and Wildlife Service's Updated Report in Compliance with Section 662 of the Fish and Wildlife Coordination Act

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE COLORADO—UTAH
1426 FEDERAL BUILDING
125 SOUTH STATE STREET
SALT LAKE CITY, UTAH 84138

In Reply Refer To
(ES)

April 20, 1977

MEMORANDUM

TO: State Director
Bureau of Land Management
Denver, Colorado

FROM: Acting Area Manager
Fish and Wildlife Service
Salt Lake City, Utah

SUBJECT: C-099597, Application for Amendment to Right-of-Way for Strontia Springs Reservoir, Dam, Conduit, and Tunnel; C-22081, Right-of-Way Application for the Platte Canyon Road -- Denver Water Board

This is in response to your February 24, 1977 memorandum requesting an update of the Fish and Wildlife Services' August 20, 1975 report on the above subject. It is our opinion that the analysis and recommendations presented in the August 20, 1975 report (copy attached) remain valid.

We have since learned that two endangered species, the American peregrine falcon, Falco peregrinus anatum and the southern bald eagle, Halinaeetus leucocephalus leucocephalus are known to occur within the project area.

The peregrine falcon eyrie exists in the vicinity of the North Fork.

The birds using this eyrie are dependent upon the riparian vegetation along the North Fork as feeding grounds. Destruction or modification of this habitat could have a detrimental effect on continued success of this eyrie. The eyrie itself would not be directly impacted by the project. However riparian habitat along the North Fork was included in the Rocky Mountain/Southwestern Peregrine Falcon Recovery Team's recommendation to the Fish and Wildlife Service for critical habitat designation action.

The southern bald eagle eyrie is located on the South Fork of the South Platte. The eyrie itself will not be directly effected by the project. However, the upper part of the project may be within the feeding radius for these birds. Based on available data it does not appear that the eagles using this eyrie will be affected by this project.

Since this activity may affect a listed species, we suggest you may wish to initiate the formal consultation process as described in the enclosed proposed provisions for interagency cooperation as published in the Federal Register January 26, 1977. In this case "the appropriate official" to direct your request for a formal consultation to is the Regional Director, U.S. Fish and Wildlife Service, Regional Office, P.O. Box 25486, Federal Center, Denver, Colorado 80225.

We appreciate the opportunity to review this application.

William C. [illegible]

Attachment

August 20, 1975

Memorandum

To: State Director
Bureau of Land Management
Denver, Colorado

From: Area Manager
U.S. Fish and Wildlife Service
Salt Lake City, Utah

Subject: C-099597, Application for Amendment to Right-of-Way for Strontia Springs Reservoir, Dam, Conduit, and Tunnel; C-22081, Right-of-Way Application for the Platte Canyon Road - - Denver Water Board

This memorandum responds to Mr. Dale R. Andrus' memorandum of April 14 and constitutes the U.S. Fish and Wildlife Service's report concerning the subject right-of-way application. The report has been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Colorado State Division of Wildlife cooperated in its preparation. Concurrence in the report and our position by the Colorado Wildlife Commission are indicated by the enclosed letter dated July 17, 1975, signed by Director Jack R. Grieb.

The purpose of the Strontia Springs Dam, reservoir, conduit, and tunnel is to transport imported waters from Dillon Reservoir and waters arising in the South Platte Basin to a proposed new Foothills filter plant owned and operated by the Denver Water Board (DWB). The proposal would allow the delivery of an additional 65,843 acre-feet of water to the Denver area annually and would increase the DWB treatment capacity by 125 million gallons per day. The project will be operated in conjunction with the existing diversion, located 2.6 miles downstream from the proposed dam.

In 1962, the DWB filed its original application for those parts of Strontia Springs Diversion Dam and appendant facilities on federally managed lands as a part of the proposed Foothills project. In 1967, the Bureau of Land Management (BLM) issued a right-of-way permit (C-099597) which allowed the DWB five years to construct the Strontia Springs diversion dam and appendant facilities. After 1967, the DWB began preparation of detailed site studies, predesign, and survey work. These studies resulted in some significant changes in the original designs and led to a DWB request for an extension of time to construct. A BLM letter dated August 17, 1973, granted an extension until April 20, 1974, within which to prepare and submit an amended application and complete construction.

The letter from BLM granting the extension to the DWB recognized the need for analysis of the action after project designs were completed, as required by P.L. 91-190, the National Environmental Policy Act of 1969 (NEPA). DWB studies culminated with the "Foothills Predesign Report" in November 1973 and the "Foothills Project, Environmental Impact Assessment" in April 1974. In January 1974, the DWB filed another request for a one-year extension of time to prepare and submit an amended filing and for three years to construct. A decision was made by BLM to comply with NEPA prior to acting on the DWB request and after amended filings were received.

A new application for road access to the proposed damsite across federally managed land was filed in October 1974. An amendment to the original right-of-way permit was received from the DWB in November 1974. Based on these applications, BLM determined that the action, as proposed, could significantly affect the quality of the human environment and initiated preparation of an environmental impact statement, as required by Section 102(2)(C) of NEPA. In February 1975, BLM determined that the environmental impact statement be project specific in scope and consider the effects of construction and operation of the dam, reservoir, ancillary facilities in the canyon of the South Platte River, the treatment plant, and the water supply, along with delivery tunnels and conduits.

The right-of-way proposes construction and operation of Strontia Springs diversion dam and reservoir on the South Platte River in Sections 20, 21, 29 and 30, Township 7 South, Range 69 West, and for a conduit and tunnel extending from the dam through the adjacent east canyon wall in Sections 1, 11, 12, 14, 15, 16 and 21, Township 7 South, Range 69 West, located in Jefferson and Douglas Counties, Colorado. The various compounds of the project

would affect 60.126 acres of Forest Service lands and 50.676 acres of BLM lands.

The diversion dam, to be located across the South Platte River in the northwest 1/4 of the northwest 1/4 of Section 21, will be 601 feet in length and will rise 243 feet above the channel bedrock. When full, the reservoir will have a surface area of 95 acres, will be 1.7 miles long, and will impound 7,240 acre-feet of water. The tunnel and conduit will have an inside diameter of 10.5 feet and extend for about 3.4 miles northeastward to Denver's proposed new filter plant.

The Platte Canyon Road (Waterton Canyon Road), located between the towns of Kessler and South Platte, would follow the existing road alignment. It would be improved to 22 feet wide for 16,400 feet, 14 feet wide for 4,000 feet, and 13 feet wide for 6,400 feet.

In November 1974, a fishery study was conducted in cooperation with the Colorado State Division of Wildlife on the South Platte River. During this period, a state-federal team electrofished eight stations on the South Platte, from the Wigwam Club downstream to its juncture with the North Fork.

Data from the study indicate that the 19.5 miles of the South Platte River above the North Fork confluence and within the proposed Two Forks Reservoir area have the following significant fishery values: (1) a self-sustaining population of brown and rainbow trout, (2) a standing crop of 2,400 trout per mile--61.4 pounds per acre, and (3) a trout productivity that ranks with other high quality Colorado trout streams.

The South Platte River downstream of the confluence of the North Fork to Denver's intake dam is equally as productive as the section within the Two Forks Reservoir site, which was recently electrofished (Windell, 1974). The section is accessible by bike or on foot, making it even more distinctive than the highly used reach within the reservoir site.

The South Platte Canyon area supports mule deer, black bears, wild turkeys, elk, and blue grouse--all of which provide sport hunting. A herd of bighorn sheep which inhabit the relatively roadless canyon below the juncture of the North Fork provide a unique experience for observation in their natural setting by those who hike or use a trail bike through the canyon. A great variety of other game and nongame birds, mammals, and other wildlife inhabits the South Platte drainage.

Due to the ready access and closeness of the outstanding trout stream to the people along the Front Range, including the Denver metropolitan area; its distinctness for natural reproduction of trout; its high potential for fishery management; the natural beauty of the stream in the montane setting; the great variety of wildlife, both game and nongame which inhabits the drainage, we cannot accept the degradation to the South Platte River that would result from the construction and operation of Strontia Springs Dam and reservoir. It is the policy and mandate of the U.S. Fish and Wildlife Service that these values be protected and preserved, and in good conscience, we cannot concur in the project. Therefore, we recommend that the right-of-way permit for Strontia Springs Dam and reservoir be denied.

However, if the Bureau of Land Management elects to issue the right-of-way permit for Strontia Springs Dam and reservoir, the U.S. Fish and Wildlife Service and the Colorado State Division of Wildlife would reserve the right to be consulted in the formulation of the stipulations to the right-of-way permit to protect fish and wildlife values in the Platte Canyon area.

Furthermore, the construction of the Platte Canyon Road is an integral part of the Strontia Springs project. Therefore, to ensure that the Platte Canyon area continues in its present condition, we cannot support the construction of this roadway and recommend that this permit be denied also.

We appreciate the opportunity to review this application.

[illegible] Thoesen

Enclosures

cc:
Denver RO (ES)

STATE OF COLORADO
Richard D. Lamm, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
Jack R. Grieb, Director
6060 Broadway
Denver, Colorado 80216 (825-1192)

April 13, 1977

Mr. Robert H. Shields
Area Manager
United States Fish and Wildlife Service
1426 Federal Building
125 South State Street
Salt Lake City, Utah 84138

SUBJECT: C-099597, Application for Amendment to Right-of-way for Strontia Springs Reservoir, Dam, Conduit, and Tunnel; C-22081, Right-of-way Application for the Platte Canyon Road -- Denver Water Board

Dear Bob:

Division personnel have reviewed the Draft Memo to the Bureau of Land Management which updates the Fish and Wildlife, August 20, 1975, report.

It is also our opinion, as stated in the update, that further modification or degradation of the North Fork of the South Platte River could adversely impact the habitat of the peregrine falcon. Impacts, quite obviously, will be somewhat dependent upon extent and location of habitat degradation.

We appreciate being given the opportunity to review the analysis and agree with the update as written.

Sincerely yours,

Jack R. Grieb
Director

JRG:ps

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LITERATURE AND INFORMATION SOURCES CITED

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GLOSSARY

GLOSSARY

Acre-foot. A unit for measuring volume, equal to the quantity of water or other material required to cover one acre to a depth of one foot or a volume of 43,560 cubic feet.

Archaeological excavation. In a salvage situation in which sites will be destroyed as a result of construction, excavation is often the only means of information salvage. All excavated materials are subjected to intensive laboratory analysis, description, and publication. By definition it is in itself a destructive activity, as the in-place value of the resource is destroyed through excavation.

Archaeological inventory. An inventory is an attempt to locate every site within a specified region, or in the case of a right-of-way, every site along the right-of-way. The inventory requires covering the surface on foot, horseback, or vehicle, in transect intervals of 100 yards or less. An inventory produces as the end product an itemized description of each site, its location on a suitable detailed map, a photograph, and a collection of artifacts from the surface of each site.

Archaeological resources. Objects and areas made or modified by man and the data associated with these artifacts and features. These resources rest in or on the ground.

Archaeological survey. A survey is an extension of an inventory. In addition to site location the site collections are analyzed and each site is assigned to a culture period or periods. The analysis includes laboratory study or artifacts: cleaning, labelling, typological analysis, etc. If acquired, any datable samples are submitted for dating. The site types and artifacts are described in a published report which synthesizes all of the known archaeological data in the region studied.

Artifact. A material object made or modified in whole or in part by man. Among the most common artifacts or archaeological sites are stone tools, chips, projectile points, and similar lithic debris.

Available water-holding capacity (soils). The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil.

Average annual precipitation. An average of the yearly precipitation usually expressed in inches of water that fall or are computed to fall at a point or on an area during a specified number of calendar or water years.

Axis. (fold) In a fold, a line that connects the central points of each constituent stratum, from which its limbs bend; in a syncline, it is the trough, and in an anticline it is the crest.

Background. That portion of the visual landscape lying from the middleground limits to infinity. Color and texture are subdued in these landscapes, which are concerned with the two-dimensional shape of landforms against the sky.

Base flow. Sustained or fair-weather streamflow. In most streams, base flow is composed largely of ground water effluent.

Baseline data. Information collected prior to the initiation of an environmental analysis which forms a basis for the determination of environmental impacts.

Biochemical oxygen demand (BOD). The measure of the relative oxygen requirements of municipal and industrial wastewaters.

Biomass. Living weight.

Browse. The part of leaf and twig growth of shrubs, woody vines, and trees available for animal consumption.

Calcareous rock. A sedimentary rock containing an appreciable amount of calcium carbonate.

Carrying capacity. The uppermost limit of a specific area's ability to support a given population.

Characteristic Landscape. The overall visual impression resulting from the combination of topography, vegetation, water resources, and cultural features that can be described in terms of the visual dominance elements.

Consumptive use. The quantity of water discharged to the atmosphere or incorporated in the products of the process in connection with domestic use, vegetative growth, food processing, or an industrial process.

Cubic feet per second (cfs). A unit expressing rates of discharge, equal to the discharge through a rectangular cross section, one foot wide and one foot deep, flowing at an average velocity of one foot per second.

Cultural resources. Objects, structures, sites, and districts that pertain to native peoples, or other communities; they are generally classified as historic and prehistoric (often referred to as archaeologic). Such areas are important because of their educational, interpretive, and scientific value, because they are vital to the preservation of a subculture, or because they are representative examples.

Degradation. The wearing down or away, and the general lowering or reduction of the Earth's surface by the natural processes of weathering and erosion.

Discharge. The flow of a stream or canal, outflow from a basin, or flow of water from a pipe. Water discharge includes the sediment mixed with and solids dissolved in the water.

Dissolved solids. Solids that originate mostly from rocks and are in solution. Some colloidal material is treated as if it were in solution in determining dissolved solids. The total dissolved mineral constituents of water.

Dissolved oxygen (DO). A measure of the oxygen content of a volume of water.

Ecology. The study of the relation of organisms or groups of organisms to their environment; animals and plants in their relation to each other.

Ecosystem. Complex self-sustaining natural system which includes living and nonliving components of the environment and the interactions that bind them together. Its functioning involves the circulation of matter and energy between organisms and their environment.

Eolian soil material. Soil material accumulated through wind action.

Erodible. Susceptible to erosion. (Expressed by terms such as highly erodible, slightly erodible, etc.)

Erosion surface. A land surface shaped and subdued by the action of erosion, especially by running water. The term is generally applied to a level or nearly level surface.

Evaporation. The process by which water is changed from the liquid or solid state into the vapor state.

Evapotranspiration. The process by which water is withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Fault. A surface or zone of rock fracture along which there has been displacement, from a few centimeters to a few kilometers in scale.

Fauna. All animals of a particular period or region, taken collectively.

Flora. All plant life of a particular period or region.

Foreground. That portion of the visual landscape lying generally from one-quarter to one mile beyond the viewer. Details of human-size features are visible at this distance, and all features are large-scale elements.

Form. The three-dimensional shape of an object or a collection of objects that appear as one.

Formation. A distinctive bed or sequence of rocks selected as a convenient unit for mapping, description, and reference.

Fossil. Any remains, trace, or imprint of a plant or animal that has been preserved by natural processes, in the Earth's crust, since some past geologic time; any evidence of past life.

Gaging station. A particular site on a stream, canal, lake, or reservoir where systematic observations of gage height or water discharge are obtained. A streamflow gaging station is a gaging station on a stream.

Gallons per minute (gpm). A unit expressing rates of discharge. One cubic foot per second is equal to 448.8 gpm or 646,272 gpd (gallons per day).

gpd. Gallons per day.

gpm. Gallons per minute.

Ground water. That part of subsurface water that completely saturates the rocks and is under hydrostatic pressure.

Habitat. A specific set of physical conditions that surround the single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

Historical site. Any place associated with a significant event, an important person, or a cultural activity of the past. Historic in most cases is 50 years old or older, except for rare instances where exceptional events have taken place, such as the site of the first atom bomb detonation.

Hardness. A property of water which has generally been associated with the effects observed in the use of soap, or with the deposit left by some types of water when they are heated. Hardness, expressed in terms of an equivalent quantity of calcium carbonate ($CaCO_3$), is calculated from the equivalence of calcium and magnesium, or is determined by direct titration. Hardness caused by calcium and magnesium (and other ions if significant) equivalent to the carbonate and bicarbonate is called carbonate hardness; the hardness in excess of this quantity is called noncarbonate hardness.

Intermittent stream. One which flows part of the time, as after a rainstorm, or during part of the year.

Invertebrate. An animal without a backbone or spinal column.

Irrigation. The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.

Jackson Turbidity Unit (JTU). Unit used to measure the turbidity or amount of suspended particulate material carried by a stream.

Joint. A surface of actual or potential fracture or parting in a rock, without displacement; the surface is usually plane and often occurs with parallel joints to form part of a joint set.

Landform. A discernible natural landscape, such as a floodplain, stream terrace, plateau, valley, etc.

Landscape Visual Unit. Smaller land units into which viewsheds are divided. These distinct now-overlapping units are areas that have differing degrees of visual exposure relative to the viewer. They are defined according to their distance (foreground, middleground, and background) from the viewer, the direction(s) of travel along roads from which they may be viewed, and according to the unique combinations of viewshed sequences providing the view(s).

Leach. To dissolve out by the action of a percolating liquid.

Limiting factor. A critical living or nonliving element of an ecosystem necessary for an organism to survive that is in the least supply.

Lithic Debris. Cultural material made of stone.

Low, medium, and high flows. Arbitrary designations based on the percentage of time a water discharge was equaled or exceeded. High flows are those greater than a discharge that was equaled or exceeded 20 percent of the time; low flows are those less than a discharge that was equaled or exceeded 80 percent of the time; and medium flows are those greater than a discharge equaled or exceeded 80 percent of the time, but less than a discharge equalled or exceeded 20 percent of the time.

Macrohabitat. General habitat values that are shared by all species of the same order, family, or genus.

Macrointertebrates. Organisms lacking a spinal cord which inhabit the bottoms of aquatic environments.

Mg/l. Abbreviation for milligrams per liter, the unit of expression for the concentration of dissolved minerals in water.

Middleground. That portion of the visual landscape lying generally from the limits of foreground to 8 miles beyond the viewer. Overall patterns of vegetation and earthform constitute texture which is no longer distinguishable in human-size features.

National Advisory Council on Historic Preservation. An advisory group appointed by the President to oversee national historic preservation policy. Comments on federal undertakings that might effect historic sites.

National Register of Historic Places. A listing maintained by the National Park Service of architectural, historical, archaeological, and cultural sites of local, State, or national significance. (Historic Preservation created by the Act of 1966).

Niche. A faunal species function within the ecosystem.

Normal fault. A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of the fault is usually 45-90°.

Paleontology. The study of life in past geologic periods, based on fossil plants and animals and including phylogeny, their relationships to existing plants and animals, and the chronology of the earth's history.

Parts per million (ppm). A unit for expressing concentration of dissolved solids and sediment. A part per million of dissolved solids is a unit weight of dissolved solids in a million unit weights of a water-dissolved solids solution. A part per million of sediment is a unit weight of sediment in a million unit weights of water-sediment mixture.

Perennial stream. One which flows continuously from source to mouth during most years.

Permeability. (1) The quality of a soil horizon that enables water or air to move through it. (2) The property or capacity of a porous rock sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it.

(pH) Hydrogen-ion concentration. The negative logarithm of the concentration of hydrogen ions. The pH is a measure of the activity of the hydrogen ions and thus is a numerical value or measure of the alkalinity or acidity of the water. Ordinarily, water having a pH of 7.0 is regarded as neutral; a pH lower than 7.0 indicates acidic properties; and a pH higher than 7.0 indicates alkalinity. However, a water that is acid, alkaline, or neutral according to the pH scale is not necessarily the same by another standard.

Physical properties (of soils). Those characteristics, processes, or reactions of a soil which are caused by physical forces and which can be described by, or expressed in, physical terms or equations.

Porosity. The property of a rock, soil, or other material containing interstices. It is commonly expressed as a percentage of the bulk volume of material occupied by interstices, whether isolated or connected.

Precipitation. The discharge of water, in liquid or solid state, out of the atmosphere, generally upon land or water surface. The term is also used to designate the quantity of water that is precipitated.

R. Range, one of the north-south rows of townships in a U.S. public-land survey. (Plural: Rs.)

Rainfall. The quantity of water that falls as rain only. The term is not synonymous with precipitation.

Range. The area occupied by a given species for all or a portion of their lives.

Raptor. Birds of prey with sharp talons and strong notched beaks; hawks, owls, vultures, etc.

Recharge. The process by which water moves into an aquifer, or the amount water that moves into an aquifer.

Reclamation. The process of returning resource values to lands affected by controlled land disturbances to a form and productivity consistent with a stated land use plan which includes a stable ecological state, is compatible with the values of the surrounding lands, and is executed on lands which are fully capable of supporting the uses or higher or better uses which they were capable of supporting prior to disturbance.

Controlled land disturbance. Including mining, oil and gas recovery, access roads, powerlines, pipelines, and any other activities which alter the original ground surface and the resources (either surface or subsurface), and require prior approval by the regulatory authority.

Rehabilitation. The process of returning resource values to lands affected by uncontrolled land disturbances to a form and productivity consistent with a stated land use plan which includes a stable ecological state.

Uncontrolled land disturbance. Includes fire, floods, landslides, earthquakes, or other types of disturbances arising from natural causes, catastrophic occurrences, or uncontrolled human activity, which usually results in the destruction or degradation of the resource values on the lands affected.

Restoration, soil. Returned to the original condition.

Return flow. The water returned to the stream system or source after being used. Return flow is generally equal to water use less consumptive use.

Riparian. Situated on or pertaining to the bank of a river, stream, or other body of water.

Riprap. A layer of large, durable, dense, specially selected and graded, broken rock fragments thrown together irregularly (as in deep water or on a soft bottom) to prevent erosion, through wave action or strong currents, and thereby preserve the shape of a surface, slope, or underlying structure. It is used for irrigation channels, river-improvement works, spillways at dams, and shore protection.

Runoff. The water from rainfall or melting snow that enters the stream system rapidly either as overland flow or as subsurface flow that does not reach the zone of saturation, and whose time spent underground is so brief that its rate of movement into the stream is almost as rapid as overland flow

Scouring. The powerful and concentrated clearing and digging action of flowing oil or water, especially the downward erosion by streamwater in sweeping away mud and silt on the outside curve of a bend, or during time of flood.

Sediment yield. A unit for expressing the discharge of dissolved solids or sediment from an area. Sediment yield and dissolved-solids yield is usually given in tons per square mile per year.

Silt. (soil) A soil-texture term used in the U.S. for a rock or mineral particle in the soil, having a diameter in the range of 0.02-0.05 mm; prior to 1937, the range was 0.005-0.05 mm. The diameter range recognized by the International Society of Soil Science is 0.002-0.02 mms.

Slump. (1) Material that has slid down from high rock slopes. (2) The downward slipping of a mass of rock or unconsolidated material of any size, moving as a unit or as several subsidiary units, usually with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends.

Soil association. A mapping unit used on general soil maps in which two or more defined taxonomic units occurring together in a characteristic pattern are combined on the map into one unit. The components of the soil association may or may not be contrasting.

Soil series. A group of soils having horizons similar in characteristics and arrangement in the soil profile, except for texture of the surface portion.

State Historic Preservation Officer. An appointed official on the State level who oversees the development of historic preservation plans within the State and who provides comments for undertakings that might affect historic properties within the State.

Streamflow. The water discharge that occurs in a natural channel, whether or not the water discharge is affected by regulation or underflow.

Succession. The progressive development of vegetation toward its highest ecological expression, the climax; replacement of one plant community by another.

Suspended sediment. Sediment that is supported by the upward components of turbulent currents, or by colloidal suspension if the sediment particles are very small.

T. Township, a tract of land that is bounded on the east and west by meridians six miles apart at its south border, has a north-south length of six miles, and forms one of the chief divisions of a U.S. public-land survey. (Plural: Tps.)

Terrestrial. Consisting of or pertaining to the land in distinction from water.

Texture. The visual arrangement of the parts of a landscape feature. What constitutes texture depends on the object's distance from the viewer; the dominant texture of trees, for example, is leaves or boughs in the foreground, individual trees or groves in the middle-ground, and forests in the background.

Topsoil. Natural earth materials at or adjacent to the land surface, with physical and chemical characteristics necessary to support vegetation.

Turbidity. The measure of the degree of light penetration produced in water by materials suspended in the water.

Vertebrate. An animal having a backbone or spinal column.

Viewshed. A land unit bounded by topographic features that define the limits of views from within the unit. Adjacent viewsheds may share common topographic boundaries, or they may overlap if portions are visible from more than the unit's one viewshed sequence.

Viewshed Sequence. A road segment contained by a viewshed; a new viewshed sequence begins when the road enters a new or overlapping viewshed.

Viewshed Sequence Points. The points on a road where one viewshed sequence ends and another begins.

Visitor day. Participation in an outdoor recreation activity by one user or a combination of users that is equivalent to one 12-hour recreation visit.

Visual Dominance Elements. The four "building blocks" of the visual landscape that can be used to describe what is seen: form, line, color, and texture.

Water table. The water table is that surface in an unconfined water body at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists.

Water yield. The runoff from a drainage basin.